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Identification of Opportunities for Increased Recycling of Ferrous Solid Waste

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This study is an in-depth look at the recycling of ferrous solid waste. The study examines: the sources, types, and quantities of iron and steel scrap; the markets for iron and steel scrap; the functions of the ferrous scrap processing industry; and the technology of iron and steel scrap utilization. Problems inhibiting greater use of iron and steel scrap are identified and discussed, and recommendations are made for solutions to these problems. A survey of the ferrous scrap industry was the basis for many of the identified problems and proposed solutions, and also provided numerous statistics on the ferrous scrap industry.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
1972

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IDENTIFICATION OF OPPORTUNITIES
FOR INCREASED RECYCLING OF FERROUS SOLID WASTE

ABSTRACT

The study on which this abstract is based was conducted by Battelle-Columbus for the Office of Solid Waste Management Programs of the Environmental Protection Agency and the Scrap Metal Research and Education Foundation of the Institute of Scrap Iron and Steel, Inc., the national association of the ferrous scrap processing industry.

The United States and her people, faced with mounting environmental deterioration, are taking action to improve our environmental quality. The economic implications are large, yet the social costs of continued pollution have serious consequences.

The accumulation and increasing generation of solid waste is one important aspect of environmental damage, in addition to air and water pollution. Its problems are caused by many complex factors, which do not lend themselves to easy solution.

Ferrous solid waste is the portion of discarded iron and steel materials and the ferrous components of discarded products which is not collected and processed into iron and steel scrap by the ferrous scrap industry. While it is a minor portion of the total solid waste generated annually, it nevertheless is a highly visible and contributing factor to solid waste problems. Representing an under-utilization of a potentially valuable resource for iron and steel production, it is intimately bound to the total solid waste problem. Its alleviation should therefore have positive consequences for solid waste management.

Recycling, the continuing reuse of materials, is the positive response to the problem of waste disposal. It offers the most suitable alternative for lessening solid waste problems.

From inception, the ferrous scrap processing industry has had as its basis the recycling of ferrous solid waste into raw materials of value. This industry is best equipped to continue and accelerate solutions to the problems. Its orientation must continue to be action, and not reaction. The industry, however, must merit and receive increased cooperation from industry, its markets, government, private organizations, and individuals if success in increased recycling of ferrous solid waste is to be achieved.

Numerous problems and obstacles for increased recycling of ferrous solid waste exist. Major among them are: low growth rate of consuming industries; changing iron and steel making technology; low scrap quality from ferrous solid waste; reduced requirements for the purchased scrap proportion of total scrap consumption; poor economics of recycling ferrous solid waste; apparent discriminatory restrictions; and a lack of public awareness of the scrap processor's role in economic recycling.

The key to achieving recycling success is increased market demand for iron and steel scrap, the value produced from ferrous solid waste. However, if normal market demand does not provide for both profitable processing of ferrous solid waste by the scrap industry and its subsequent economic use by the iron and steel consuming industries, a reordering of our traditional commercial objectives based on profit and efficiency will be required in order to include the social cost of an increasingly deteriorating environment.

A number of potential opportunities exist for increased recycling of ferrous solid waste. But with few exceptions, significant effort and cooperation by all concerned--the ferrous scrap industry, the iron and steel industries, and governmental bodies--is required if the problems and obstacles to increased recycling are to be overcome and turned into opportunities. The opportunities are offered through the following channels: increased participation in current markets; development of new markets; improved scrap economics; improved scrap quality; improved logistics; minimized legal constraints; improved definition and analysis of the scrap situation; and increased public awareness of the importance of recycling and the scrap processor's role. The study presents recommendations for fulfillment of these opportunities.

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CHAPTER I
INTRODUCTION

In June, 1970, Battelle-Columbus undertook a research program for the Scrap Metal Research and Education Foundation of the Institute of Scrap Iron and Steel, Inc. (ISIS). This was through a demonstration grant of the Office of Solid Waste Management Programs of the Environmental Protection Agency.

Background of the Study

The increasing volume of solid waste in the United States is causing significant environmental problems with consequences affecting our aesthetic senses, economic costs, health, social welfare, land usage, governmental policy, and natural resources.

One approach to the reduction of solid waste pollution is to reclaim waste materials for reuse--the recycling concept. A well established industry--the ferrous scrap industry--exists to accomplish the recycling of iron and steel. Member firms of the industry have capably performed their difficult and essential functions of preparing ferrous waste materials for economic recycling as iron and steel (ferrous) scrap. This has taken place in the traditional economic environment.

However, additional dimensions have recently been added to this traditional economic environment. Improvement of the living environment and increased national concern with conservation of natural resources, the new dimensions, provide new challenges and opportunities for the recycling industry. No longer is economic gain the only driving force for recycling of waste materials. Social benefit has been added in the form of improved living conditions and preservation of resources for future generations. In an economics-based nation, this creates problems of interpretation and evaluation of noneconomics-based goals and activities.

The Institute of Scrap Iron and Steel, established in 1928, is a national association made up of approximately 1,300 processors and brokers of iron and steel (ferrous) scrap, and allied members. Member firms handle more than 90 percent of all purchased scrap consumed in the United States and exported, a $4 billion annual industry. The scrap industry plays an important part in providing three major services to our nation: reclamation or recycling of discarded ferrous products of our society and processing them into raw materials valuable for new products; conservation of natural resources through the utilization of these reclaimed materials; and beautification through the removal and elimination of these discarded materials from our landscape. The Institute, besides serving its membership's needs, is also active in projects that serve the public interest, such as beautification and training programs for the hard-core unemployed. Early recognition was given to the problems of abandoned automobiles through sponsorship of a national conference in 1964, and again in 1970.

Recognizing the need for research in the reclamation of ferrous metallics, the Institute, in 1967, formed the Scrap Metal Research and Education Foundation. The Foundation's main objective is to place more emphasis on research in the industry, though considerable work had been done in the past.

For many years, the Institute has evaluated, discussed, and worked on numerous technological, operating, and marketing problems of ferrous scrap. This has been done through its Special and Standing Committees, research contracts, government agencies including the Bureau of Mines and the Bureau of Domestic Commerce in the Departments of Interior and Commerce respectively, consumers and suppliers, and the American Iron and Steel Institute and foundry associations. Examples of studies conducted are included in the Bibliography of this report.

During this period, significant changes have occurred in the iron and steel industries, the major markets for iron and steel scrap. Iron and steel scrap represents 50 percent of the ferrous raw material input to raw steel and iron and steel castings production; the remainder comes from iron ore based pig iron and hot metal (molten pig). The changes occurring and having major impact on the scrap industry and ferrous solid waste accumulation include: changes in iron and steelmaking technology; changes in demand for iron and steel products; changes in types of iron and steel products; and increased quality and economic considerations in scrap processing and iron and steelmaking.

To offset these changes diminishing the demand for scrap by its markets, improved scrap processing equipment has been developed to supply the desired quality product. But even with this and other improvements in the scrap industry, the demand for scrap has lagged the available supply. This results in both ferrous solid waste* and an underutilization of an important raw material resource.

It was therefore deemed appropriate by the Office of Solid Waste Management Programs of the Environmental Protection Agency and the Scrap Metal Research and Education Foundation of the Institute of Scrap Iron and Steel, both vitally concerned with iron and steel (ferrous) scrap and its movement, or lack thereof, that a major study should be conducted to define the problems and seek their solutions.

The starting point for such a study is an assessment of the ferrous scrap processing and brokerage industry, and its relationship to both its sources of supply and its markets. The study should outline problem areas that inhibit more effective recycling, and should provide a data base for further policy and investment decisions by both public and private bodies concerned with solid waste programs. The study should further identify opportunities for increased recycling, and recommend action programs to achieve this objective. It is toward those ends that Battelle-Columbus has conducted this study.

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* Ferrous solid waste is defined as that portion of discarded iron and steel materials and the ferrous components of discarded products which is not collected and processed into iron and steel scrap.

Objectives and Scope

The major objective of the study on which this report is based was to identify opportunities for increased recovery and recycling of ferrous solid waste. In order to achieve this, the following subobjectives were undertaken:

- Provision of a data base on the present iron and steel scrap processing industry
- Examination of the structure and functions of the ferrous scrap industry, and its relationships to its sources of supply and markets
- Examination of those factors that tend to inhibit the industry from performing its role to a greater extent than at present and which thereby lead to ferrous solid waste problems
- Identification of opportunities for the industry to more effectively contribute to solutions of the metallic solid waste problems of this nation.

Research Methods

To provide overall guidance and assistance in the study, a Task Force was established from the Institute's active committees having a direct bearing on the goals of the research study. These men, brought into the active participation of the Scrap Metal Research and Education Foundation, met quarterly as a group and individually as required with Battelle, and provided invaluable assistance during the progress of the study. In addition, Institute staff and consultant personnel made frequent contributions to the project.

Battelle Memorial Institute, as prime contractor, used its interdisciplinary approach to carry out five primary functions:

(1) A literature search and evaluation to assess the current documented and published information was made. References cited and having implications for the study are listed in the Bibliography and throughout the report.

(2) An extensive survey of the ferrous scrap industry to identify the industry, its capabilities, and its problems was conducted. The actual survey was subcontracted by Battelle to Chilton Research Services, a Division of the Chilton Company in Philadelphia, Pennsylvania, a qualified outside organization experienced and equipped in survey techniques. A copy of the survey questionnaire appears in Appendix A. Systematic selection on a geographical basis was made of 249 firms in the industry, representing a sample size of firms accounting for approximately 15 percent of the industry's volume. The geographic distribution of interviews is shown on page A-4. Personal interviews and telephone interviews were 50:50. Raw data from the survey appears in Appendix A. Interpretation and analysis of the data appears throughout the report, and is noted by "Source: Extensive Survey".

(3) In-depth interviews were then conducted in person by the Battelle project team to add detail and insight into the problems identified in the Extensive Survey, to identify the ferrous solid wastes most difficult to collect or process, to uncover the problems involved in disposing of the solid wastes generated during the processing of iron and steel scrap, and to determine other types of restrictive problems facing the industry. Problems peculiar to specific regions received attention.

In-depth interviews were held with over 80 individual firms, organizations, and government agencies representing the sources and markets for iron and steel scrap, members of the ferrous scrap industry, and others associated with recycling opportunities.

(4) Technical and economic evaluation to determine the obstacles and opportunities for increased recycling, based upon the information developed during the preceding functions, then began. The sources and markets for ferrous solid waste were analyzed. The ferrous scrap industry's relationships, capabilities, and problems with regard to both sources and markets were evaluated. Obstacles were defined and analyzed; potential opportunities were identified; action plans for implementation were developed.

(5) Synthesis and recommendations for further research and action leading to increased recycling, and therefore alleviating our solid waste problems, conserving natural resources, and adding to the economic and social well-being of our nation, was the final phase of the study.

NOTE: This study includes numerous statistical tables, based upon a variety of sources, e.g., American Iron and Steel Institute, U.S. Bureau of Mines, Institute of Scrap Iron and Steel, Inc., and others. In each case, the source(s) selected for a particular table was made to best illustrate that table's purpose and to provide consistency within the table. However, due to the variety of sources and methodology of statistical collection and content, some minor inconsistencies may exist in comparing one table to another.

CHAPTER II
SUMMARY

Environmental Quality

The United States and her people, faced with mounting environmental deterioration, are growing more aware than ever before that continued exploitation of our environment has grave social consequences for our nation. Our economically motivated and technology based society has given us a standard of living and a quantity of life unsurpassed in history; yet, in the process the quality of that life has been adversely affected.

Three basic types of interrelated environmental problems exist: pollution, land misuse, and natural resource depletion. And pollution, the most prominent type of environmental problem, has three sources: air, water, and solid waste. Solid waste, the unwanted residue of our society, has only recently become of national concern, due to its increased generation magnifying current disposal problems and costs, and its affront to our aesthetic senses.

Generation of solid waste in 1969 was estimated at 4,340 million tons.(1) While agricultural and mineral wastes comprise the major portion (3,980 million tons), the type most familiar, i.e., residential, commercial, institutional, and industrial waste amounted to 360 million tons, or almost 2 tons per capita in the United States. Of the latter, less than 50 percent was collected, at an annual cost of $4.5 billion.(2) Most is simply deposited on the land in open dumps, or left to accumulate at its sources.

Solid waste problems obviously exist. But these problems are complex, and defy simple solution. In addition, the economic implications of an improved environment, while difficult to measure, are great. No longer may the most efficient manufacturing process or waste disposal method be used if by doing so the environment is impaired. Pursuit of economic goals can no longer disregard basic value and environmental considerations as they have too often done in the past.

Profits will be maximized, but subject to environmental constraints. However, how far and how fast we progress in the direction of environmental quality improvement balances delicately on achieving, within our socio-politico framework, an economic cost/environmental benefit equilibrium.

Solid Waste Alternatives

Six basic alternatives exist for solid waste management. They are to:

(1) Continue polluting, which is obviously unacceptable due to both environmental and economic considerations

(2) Limit use of current materials contributing to pollution, which could have severe economic consequences

(3) Make greater use of biodegradable materials, which has some merit but is limited in their use due to economic and technological factors

(4) Develop new uses for solid waste in its present form, which offers limited applications

(5) Improve disposal of waste through improved economic and sanitary methods, which has certain merits but is a waste of potential resources

(6) Recycle as great a portion of the solid waste as possible and/or required, while at the same time improving the economics and sanitation of disposal of the residue. This is the most promising alternative, both environmentally and economically.

Recycling, the conversion and reuse of discarded products in the production of new, offers the best potential alternative for improving both our environmental and economic climate. While a totally "closed system", one in which all waste is recycled for useful and productive purposes, is not feasible, greater utilization than at present is necessary. Five basic reasons exist for the "why" of economic recycling of solid waste. They are:

(1) Alleviation of mounting solid waste problems and costs

(2) Conservation of natural resources

(3) Use of an economic raw material source

(4) Aesthetic and health considerations

(5) Avoidance of economic dislocations within processing and supplying industries.

It should be noted, however, that the effect of increased recycling on existing industries, e.g., virgin materials producers, must also be considered.

Ferrous Solid Waste

Ferrous solid waste is an integral part of our total solid waste problem. Originating in the discards of society, it represents the loss of potentially valuable resources for recycling and presents high visibility in such forms as junked vehicles, steel cans, and ferrous components of abandoned buildings. Nevertheless, when collected and processed into iron and steel scrap by the ferrous scrap processing industry, it represents a very real resource for production of iron and steel.

Iron and steel scrap represents approximately 50 percent of the raw material input for the production of iron and steel, with natural resource iron-bearing materials, e.g., iron ore, comprising the remainder. Scrap originates in three basic sources: (1) home, or mill revert scrap, generated during the production of iron and steel; (2) prompt industrial scrap, generated during the fabrication of mill products into consumer and industrial products by the metalworking industries; and (3) obsolescent scrap, the product of value obtained from society's discards, i.e., ferrous solid waste. The latter two types are collectively known as purchased scrap, as they are collected and processed externally to the iron and steel producer by the ferrous scrap industry.

Some portion of the prompt industrial scrap is properly prepared at the generating plant for use, and therefore involves only a brokerage operation with direct shipment to the consumer by the scrap industry; the remainder, however, requires handling and/or processing by the industry. Obsolescent scrap is virtually all handled and processed by the scrap industry.

In 1970, almost 86 million net tons of iron steel scrap were consumed in the United States, and over 10 million tons were exported. Domestically, home scrap represents about 60 percent of total consumption; prompt industrial 20-25 percent; and obsolescent scrap 15-20 percent. The respective tonnages of each in 1970 approximated 53, 20, and 14 million net tons.

Home scrap is generally consumed within the plant in which it originated, although some interplant shipments take place. Prompt industrial scrap also normally flows smoothly in the recycle chain, due to its known composition and quality. But ferrous solid waste, the raw material for obsolescent scrap, because of its heterogeneous sources, unknown quality, and containment in complex final products, presents the major problem for increased recycling. Only about 60 percent of the total obsolete ferrous materials becoming available each year is processed and used as scrap; the remainder becomes ferrous solid waste. It is estimated that its current accumulation approximates 750 million tons. A simplified flow chart of the scrap cycle and ferrous solid waste appears as Figure II-1.

Markets for Ferrous Solid Waste

Iron and steel have formed the structural framework of our economy. Annual production of raw steel and shipments of iron and steel castings currently approximates 150 million tons. Two major sources of ferrous raw materials are used for this production: iron ore, a natural resource which is reduced in

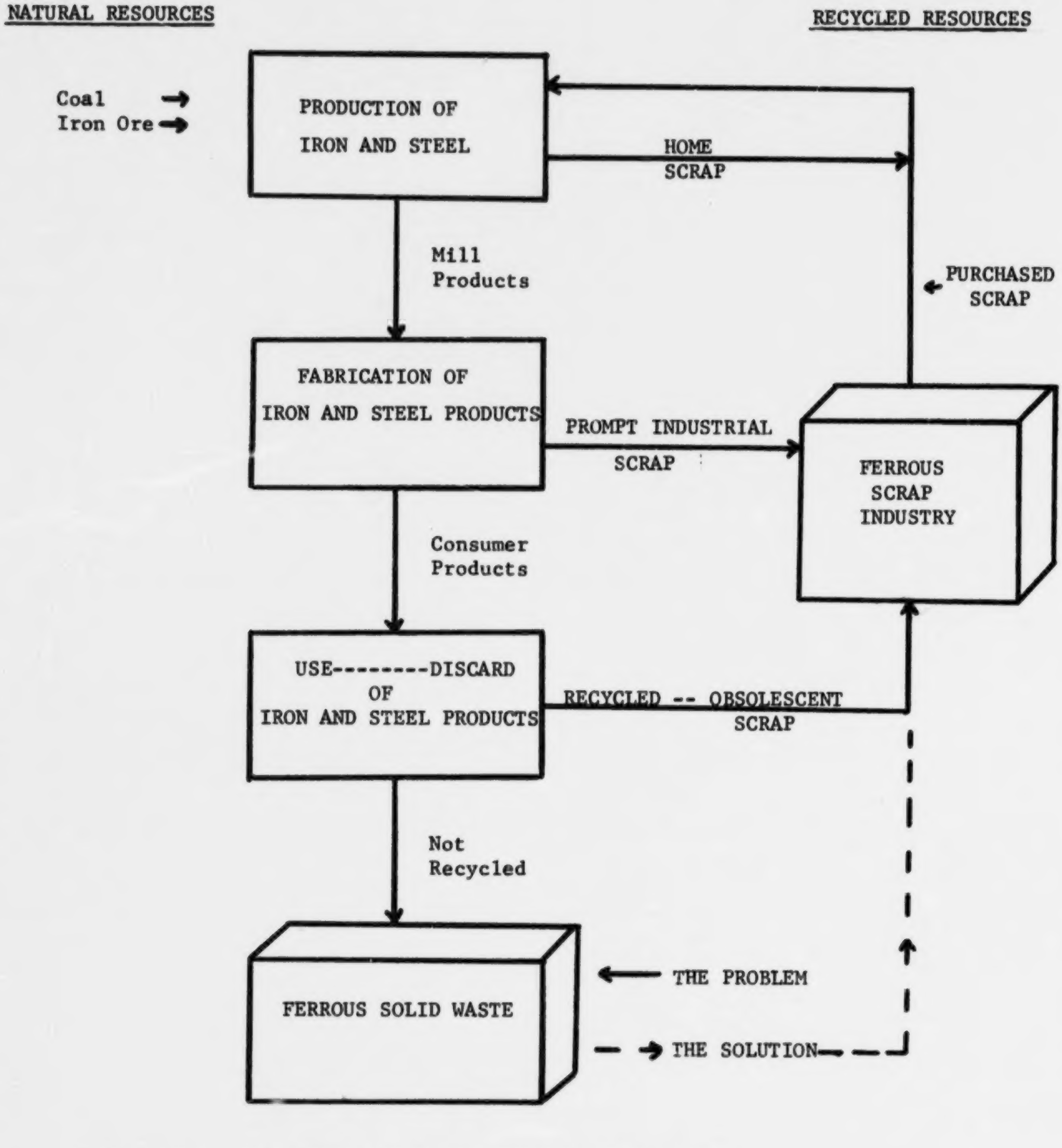
NATURAL RESOURCES
RECYCLED RESOURCES
Coal
Iron Ore
PRODUCTION OF IRON AND STEEL
HOME SCRAP
Mill Products
PURCHASED SCRAP
FABRICATION OF IRON AND STEEL PRODUCTS
PROMPT INDUSTRIAL SCRAP
FERROUS SCRAP INDUSTRY
Consumer Products
USE--------DISCARD OF IRON AND STEEL PRODUCTS
RECYCLED -- OBSOLESCENT SCRAP
Not Recycled
FERROUS SOLID WASTE
THE PROBLEM
THE SOLUTION

FIGURE II-1. THE SCRAP CYCLE AND FERROUS SOLID WASTE

blast furnaces to pig iron for foundry consumption or hot metal (molten pig iron) for steelmaking consumption, and iron and steel scrap, the end product of the scrap processing industry, and the by-product of iron and steel production and fabrication.

The markets for iron and steel scrap are the iron and steel industries. The domestic steel industry consumes about 75 percent of total scrap, the ferrous foundry industry consumes 15 percent, and the remaining 10 percent goes to export markets and minor uses.

The steel industry in 1970 produced 131.5 million tons of raw steel and consumed 69.3 million tons of scrap in that production, of which approximately 65 percent was home scrap and 35 percent purchased (prompt industrial and obsolescent) scrap. The ratio between hot metal and scrap usage approximated 55:45, and has been maintained over a number of years. Steel is produced in three basic types of furnaces, each using scrap and hot metal in different proportions.

The basic oxygen furnace, which currently produces over half of this nation's raw steel, typically uses a 30 percent scrap charge; the open hearth furnace, 35 percent of the total production, typically uses a 45 percent charge; and the electric furnace, 15 percent production, uses virtually a 100 percent scrap charge.

Iron and steel castings shipments in 1970 were 16.5 million tons. Scrap consumption was 16.2 million tons of which approximately 35 percent was home scrap and 65 percent purchased. The vast majority of gray iron castings are produced in cupola furnaces, which use an approximate 85 percent scrap charge, the remainder being pig iron. Most steel castings are produced in electric furnaces, using basically a 100 percent scrap charge.

The third major market for scrap is the export market, consuming 10.6 million tons in 1970, almost 25 percent of total purchased scrap.

Other minor markets exist, such as the use of can scrap for copper precipitation, but the future for increased recycling is tied to the above three market outlets.

The Ferrous Scrap Industry--The Vital Link Between Ferrous Solid Waste and Its Markets

The vital link which connects the sources of ferrous solid waste and its markets is the ferrous scrap industry. Since its inception in the 1800's, its major objective has been the profitable recycling of ferrous waste materials into raw material resources useful for new products.

The ferrous scrap industry produces value, in the form of iron and steel scrap, from potential wastes, thereby providing the means for preventing both greater ferrous solid waste accumulation and natural resource depletion. The basic functions of the industry are to collect ferrous scrap, process or manufacture it into physical forms and quality grades required by its markets, and to manage its purchase and sale. While there are a number of major firms, the general structure of the industry centers around small, family owned and operated enterprises. Three basic types of firms exist: the processor who assembles and prepares the scrap for sale; the processor/broker who assembles, prepares, and sells the scrap to the consuming markets; and the broker who buys from the processor or other sources direct, such as prompt industrial scrap from industrial accounts, and sells to the markets direct with little or no processing on his part. It has been estimated that approximately 50 firms are brokers, 150 are processor/brokers, and the remainder are processors and collectors. In total, the number of firms approximates 1,800 operating slightly over 2,000 establishments.

Scrap processing has become an increasingly complex and sophisticated operation, due to the incoming variety of materials and changing requirements of the marketplace. The quality required by the iron and steel producing industries has increased markedly as the requirements of their customers for improved iron and steel products have increased. On the other hand, the complexity and increasing amounts of nonferrous materials used in consumer goods, a major source of obsolescent scrap, has made separation and preparation of quality scrap more difficult.

To effectively deal with these trends and increasing labor costs, the scrap industry, together with its equipment suppliers, has developed processing equipment capable of producing quality scrap products. Three major pieces of equipment have contributed to this upgrading. The 1940's witnessed wide-spread installation of hydraulic balers, with their capacity to bundle the increasing amount of light, flat-rolled material. In the late 1950's, the hydraulic guillotine shear and conveyor systems provided properly sized and segregated scrap. However, scrap processing made vast strides in the 1960's. The advent of shredding or fragmentizing equipment capable of producing the most uniform scrap yet developed from complex consumer goods was a major contribution. Further contributions to improve scrap quality were made by wide-spread adoption of shears, sorting conveyor systems, improved briquetting and baling equipment, as well as other equipment and processing innovations. But this progress has been expensive. A continuous flow of material through this equipment is required for profitable operation, a characteristic often lacking in scrap demand.

Maintenance and improvement of the current scrap cycle is vital to increased recycling success. The ferrous scrap industry is equipped to continue and accelerate solutions to many of our ferrous solid waste problems. Orientation must continue to be action, not reaction. Increased cooperation among the scrap industry, other industries, government, and private organizations and individuals is required if success in increased recycling of ferrous solid waste is to be achieved, as numerous problems and obstacles exist to increased recycling.

Major Problems and Obstacles to Increased Recycling

Numerous problems and obstacles exist for increased recycling of ferrous solid waste. They appear on the following page in charted form (Figure II-2). Some have a direct inhibiting effect on increased recycling, while others have only an indirect or minor effect. In addition, a number of the problems listed within the scrap industry are applicable primarily to only the small or medium-sized processor. The major ones are subsequently discussed.

Low Growth Rate of Consuming Industries

Increased recycling of ferrous solid waste is dependent to a great extent on increased demand for iron and steel scrap by its major markets--the domestic iron and steel industries. A key determinant of this demand is the increased sale of iron and steel products and the associated growth in scrap demand for supplying the required metallic charge for iron and steelmaking.

The domestic iron and steel industries are not keeping pace with the growth in the American economy. Over the past decade, the economy as measured by gross national product, industrial production, its durable manufacturing components, or any number of other indicators, has grown at an annual rate in excess of 5 percent versus about 3 percent for iron and steel. Continuation of these trends is expected, with perhaps the gap even widening between iron and steel growth and that of the economy. Growth in annual iron and steel castings shipments is estimated at an annual 3 percent rate, with steel production expected to increase at an annual 2.5 percent rate.

Three basic reasons exist for the slower growth in the steel industry, the major market for iron and steel scrap. Disappearance of a historic export

LOCATION: TYPE:	At Sources	Within Ferrous Scrap Industry	Markets		Other
			For Scrap	Within Markets	
Economic	Logistics accessibility collection transportation to processor Price inadequate to induce movement Segregation costs	Increasing capital investment Labor availability/quality/costs Residue disposal Inventory holding requirements Lack of continuous operation re: cyclical markets Equipment financing problems Transportation inequities and costs Increasing operating costs	Price volatility vs. competitive products stability New uses minor Tied to two markets Availability of high quality scrap at low cost	Low growth rate Low profit industries	Lack of accurate problem definition
Technological	Complexity of goods Alloy content of mill products Low value prompt industrial scrap, e.g., turnings, borings, and chips	Equipment utilization and maintenance Difficulty of establishing "in line processing" Cyclical markets resulting in processing inefficiencies Identification and segregation deficiencies Difficulty in upgrading certain forms of obsolete scrap Products do not lend themselves to chemistry specifications	Melting practice changes Increased home scrap generation Known analysis of competitive product Quality variation Bypass systems	Past practice dominance Scrap usage technological gap	Recycling system technology limited Realistic specifications lacking
Social	Public apathy re: meaningful action Attitude toward scrap industry	Public image Site appearance		Limited recognition of environmental goals and applications Attitude toward scrap industry	Environmental/ecology "excesses" Lack of general understanding of processor's role
Political	Legal obstacles to movement, e.g., auto titling Waste handling local problem	Classification as wholesale trade vs. manufacturing Pollution control costs Discriminatary legal restriction		Pollution controls restrictions Import quotas re: tons, not value	Government tax incentive for competition, e.g., iron ore depletion allowances Multi-effort, diverse approaches
Business	Orientation toward disposal, not recycling Inefficient municipal collection units	Need for improved management techniques Individualistic nature of firms Equipment manufacturer relations Industry structure	Dominance of major producers with metallics flexibility Cyclical markets Trading vs. marketing Lack of involvement with markets	Governmental pressures	Small collector/processor decrease
Other	±15 percent nonrecoverable: product design or size or usage losses: corrosion, abrasion, and process loss, war and shipping losses	Legislative controls by those not fully cognizant of problems Transportation service, e.g., car supply and loading	Some regional imbalance re: supply and demand for scrap Export markets "cloudy"		Probable need for artificial demand stimuli Scrap accumulation/supply exceeds demand

FIGURE II-2. PROBLEMS AND OBSTACLES TO INCREASED RECYCLING OF FERROUS SOLID WASTE

balance in steel mill products to a position where imports account for approximately 15 percent of apparent domestic steel supply has had the major effect. In 1970 alone, a year in which exports, due to booming foreign demand, were at their highest levels since before World War II, imports still exceeded exports by over 6 million tons, at a cost of 9 million ingot tons, and a loss of almost 2 million tons of purchased scrap consumption. Two years earlier, in 1968, the spread of imports over exports exceeded 15 million tons, equivalent to a decrease in purchased scrap requirements of almost 4 million tons, a loss exceeding 10 percent of purchased scrap in that year. And these numbers are exclusive of both the 2 million ton export balance enjoyed during the 1950's and the increase in imports of ferrous containing consumer items such as automobiles, which if considered, would make the loss of purchased scrap even greater.

The other two factors, difficult to quantify but nevertheless significant contributors to reduced growth, are the replacement of iron and steel by competitive materials such as aluminum, concrete, and plastics, and the increased utilization of lighter iron and steel products with improved properties at the expense of heavier sections, such as high strength-low alloy steels and "thin-tin" container stock.

The major effect of this low growth rate is to reduce requirements for obsolescent scrap, the product of ferrous solid waste. Generation of home and prompt industrial scrap follows closely trends in iron and steelmaking, causing little excesses over the amount required. Ferrous solid waste, however, accumulates continuously in our disposal-oriented economy.

Changing Iron and Steelmaking Technology

Two key elements affecting the use of iron and steel scrap are the type of melting furnace employed by the iron and steel industries and the availability and cost of competitive ferrous charge materials (pig iron, hot metal, or direct-reduced ores) relative to scrap.

The greatest effect has been felt in the steel industry. Only 10 years ago, almost 90 percent of all steel produced was melted in open hearth furnaces, which at that time used a 40 percent scrap charge, now at 45 percent. Today, less than 40 percent of total steel is produced in open hearths, and this is expected to decrease to less than 15 percent by 1980. Open hearth steelmaking has been displaced primarily by the basic oxygen furnace, which uses an approximate 30 percent scrap charge, consisting mostly of home scrap. This has the effect on a ton to ton basis of reducing scrap requirements by over 30 percent based on current charging practices. Fortunately for scrap consumption, significant increases have occurred in electric furnace steelmaking and ferrous castings production using virtually a 100 percent scrap charge, which has kept the total scrap percentage at about its former levels. Thus, future scrap consumption is tied closely to achieving the continued increase in electric furnace melting to offset the decreases caused by the rise of the basic oxygen furnace at the expense of traditional open hearths.

One other factor of increasing importance to ferrous scrap consumption is the continuous casting of semifinished products directly from the steelmaking furnace. This technique requires less total steelmaking raw material charge and reduces the amount of home scrap generated during production because of its increased yields over traditional steel ingot practices. The effect is to increase the amount of purchased scrap requirements per finished ton. This would benefit recycling of ferrous solid waste, assuming the increased availability of hot metal is not used to replace scrap. On the other hand, the use of direct-reduced ores, i.e., iron ore reduced by means other than the blast furnace to a high iron content and charged directly to the steelmaking furnace, could partially offset these gains by its substitution for scrap. However, it may complement scrap and promote an acceleration in installation of electric furnace steelmaking, which in the long run would be beneficial to scrap consumption.

The technical feasibility of using increased scrap proportions in iron and steelmaking charges has been amply demonstrated. The melter will, however, make his decision on economic operating practices and quality considerations. He will use the most economic ferrous raw material available. The scrap industry can influence that decision by providing lower cost, higher quality products and improved technical service on optimum scrap usage.

Quality of Scrap From Ferrous Solid Waste

Scrap quality is an extremely important consideration for the consumer of iron and steel scrap. The key quality factors, from his standpoint as well as that of the scrap processor, are size and shape, density, and metallic and nonmetallic impurities. Size, shape, and density are related basically to operating practices for the melting furnaces; impurities, while obviously influencing charging and melt practices, are of major concern with regard to further mill finishing and properties in the final mill product.

The iron and steel industries are under continuous pressure from their markets for mill products that will meet increasingly rigid specifications. Their operating practices and the raw materials from which iron and steel are produced are therefore subject to increasing quality requirements.

The main competitor to scrap as a ferrous charge raw material is iron ore, in its reduced form as pig iron, a product of known chemistry and consistent size, shape, and density. Two forms of scrap, home and prompt industrial, are also basically of known chemistry, within a limited range, and with modern scrap processing equipment and techniques can be manufactured into the desirable physical form. As a result, they move freely into the scrap cycle, presenting no real quality problems.

However, obsolescent scrap, the product of ferrous solid waste, is significantly different. Occurring in many shapes and forms, from steel cans to junked autos, it presents a number of quality problems. Great strides have been made by the scrap industry toward processing of this material into the required physical forms with lower residuals, through the use of shredding systems and other modern equipment. However, the complexity and increasing amounts of non-ferrous materials used in consumer and industrial goods, have made extremely difficult the separation and elimination of the undesirable residual elements for iron and steelmaking, such as copper, lead, and tin. As a result, except in periods of peak demand or hot metal shortages, the availability and low cost of higher quality, e.g., prompt industrial scrap, forms of ferrous charge materials diminish any real incentive for the scrap consumer to use or the scrap processer to collect and process obsolete scrap with its potential quality problems.

Reduced Requirements for Purchased Scrap of Total Scrap Consumption

The ratio of scrap consumption to total iron and steel produced has remained fairly stable over the past twenty years, with a scrap to pig iron ratio approximating 50:50. However, in 1950, purchased scrap accounted for about 50 percent of the total scrap consumed. It now amounts to under 40 percent, a decrease of 20 percent in purchased scrap requirements.

This has primarily been caused by decreasing yields in producing mill products, resulting in an increased generation of home scrap. In the steel industry alone, finished steel shipments as a percent of raw steel production during the period 1950-54 were 74.2 percent versus 68.0 percent in 1965-69. Caused by a number of factors such as the changing product mix toward lighter sections, increased finishing operations, and more rigid product specifications, the net result has been an unwanted increase in "self-supply" by the iron and steel industries of their scrap requirements. The basic oxygen furnace, for example, can be almost totally self-sufficient, except for short-term disequilibriums.

Therefore, while the total scrap consumed over the past 20 years has followed closely the growth in iron and steel production, the absolute amount purchased has shown little, if any, increase over this period.

Poor Economics of Recycling Ferrous Solid Waste

It is generally accepted that the vast majority of potential ferrous solid waste that can be economically recycled is currently being recycled. Scrap produced from ferrous solid waste is the most costly to collect and process, and due to its relatively low quality, brings a low price without extensive and costly upgrading. In addition, the "break-even" point for the scrap processor has been steadily increasing due to higher labor and transportation costs coupled with increased equipment expenditures and operating costs.

As a result, there is little economic incentive, except in periods of high demand, to attempt to separate ferrous solid waste from other municipal waste, or to scour our countryside for discarded products containing ferrous materials of potential value.

Apparent Discriminatory Restrictions

Iron ore and scrap are the two sources of iron units available to the iron and steel producer. They compete metallurgically, and while subject to certain operating considerations, are equally of value to the melter in obtaining iron. Iron ore has a typical iron (Fe) content of 60 percent, and is used to produce hot metal in the blast furnace which has a typical Fe content of 94 percent. Scrap, the other source of iron for steelmaking, has a nominal Fe content exceeding 90 percent.

Two apparent benefits exist for the iron ore producer as he competes with the scrap processor as an iron source. The first involves rail freight rates. Transportation is a major cost for the scrap processor. Rail is the primary land mode of transportation for both iron ore and processed scrap. Conceptually, transportation rates should not alter the competitiveness of alternative inputs to any manufacturing process; iron ore and scrap are metallurgically competitive.

A recent study at Battelle indicated that iron ore has an apparent competitive advantage of approximately $1.50 per gross ton over ferrous scrap because of the rate structure. The relative Fe contents, the coal energy equivalent for reduction of the oxide ore to metallic form, and the relative role of rail transportation in the movement of ore, scrap, and coal were considered in this analysis.

In reviewing the economic sensitivity of steelmaking cost to scrap cost, it appears that scrap consumption is impeded by the existing freight rate discrimination. In the short run, the removal of the discrimination by lowering scrap freight rates would enable a significant reduction in the finished cost of steel ingots; in the long run, an improved expected rate of return would be realized in scrap-based steelmaking investment.

Therefore, the apparent discriminatory rate structure is a contributing factor toward present scrap markets being impeded in preference to the rate-favored use of iron ore; future markets being curtailed through the artificial diversion of investment to ore-intensive steelmaking that might otherwise be applied to scrap-intensive steelmaking; natural resources being exploited when they could be conserved; potential scrap that could be recycled does not move; and the environment is polluted by the accumulation of ferrous solid waste.

The second benefit for iron ore producers involves federal tax laws, which allow a 15 percent depletion deduction from gross income in computing their net taxable income. No such advantage accrues to the scrap processor.

Another area of apparent discrimination involves local zoning, licensing, or other legal restrictions placed upon the scrap processor due to lack of recognition of his function. For example, urban renewal projects normally make provision for relocation of industrial firms, but not for the processor or collector who could formerly serve those accounts economically due to their proximity. Another example occurs when fencing regulations are applied equally to the scrap processor, a manufacturer, as well as to the junkyard or auto wrecker, two distinct other categories of business.

Lack of Public Awareness of the Scrap Processor's Role in Economic Recycling

While environmental concern is exhibited everywhere and "recycling" is today's popular concept, there is still little public awareness of the scrap processor's role in achieving the concept. Still often thought of as junk collectors who serve no useful purpose other than their own, the vital role the scrap industry performs in cleaning up our environment and providing the means for conservation of our natural resources is not generally known. As a result, the scrap industry often has been bypassed in environmental decision-making.

Major Opportunities for Increased Recycling of Ferrous Solid Waste and Recommendations for Achievement

The key to achieving recycling success is increased profitable demand for iron and steel scrap, the value produced from ferrous solid waste. However, if economic demand is not present, a reordering of our traditional commercial objectives based on profit and efficiency will be required, in order to include the social cost of an increasingly deteriorating environment.

A number of potential opportunities exist for increased recycling of ferrous solid waste. However, with few exceptions, significant effort and cooperation on the part of all concerned--the ferrous scrap industry, the iron and steel industries, and governmental bodies--is required if the numerous problems and obstacles to increased recycling are to be overcome and turned into opportunities.

The opportunities fall into eight basic areas. In many cases they are interrelated, mutually dependent, or could be classified in other than the selected area. A detailed listing outlining the opportunity areas and the recommended actions to capitalize on those opportunities appear on pages 37 - 41.

Increased Participation in Current Markets

(1) Provide Greater Technical Service to Markets (SI)*. With the exception of the major scrap firms, little, if any, technical service regarding the optimum use of scrap in melting operations to provide the best finished product at the lowest cost is available. The relationship between the scrap dealer and his customer has been one basically of trading. The scrap processor has limited knowledge of melting problems or the use of his products, other than when complaints

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* Recommended for action by: (SI) scrap industry, (M) markets for scrap, (S) sources of scrap, (G) government, (E) equipment manufacturers.

occur. By the same token, scrap usage by the iron and steelmaker is often dictated by past practice. Scrap today is a much different product than in the past; so is melting technology and scrap requirements.

In general, the metallurgical capabilities in medium and small firms are limited regarding optimum scrap usage. It is recognized that development of such capabilities is also expensive. It is therefore recommended that this technical assistance be provided by the Institute of Scrap Iron and Steel through addition of a Technical Director to its staff. His main function would be to provide the latest in metallurgical technology and optimum scrap utilization to member firms and the consuming industries.

In addition, it is recommended that the Institute investigate the merits of publication of a basic technical textbook/handbook on the Metallurgy of Scrap ala "The Making, Shaping, and Treating of Steel." Numerous textbooks, handbooks, etc., are available on the production of iron and steel. The information provided on optimum scrap usage, a basic raw material for ferrous products, is minimal.

(2) Expand Research, Both Technical and Economic, on Increasing the Scrap Proportion of the Metallic Charge (SI-M-G). Iron ore and ferrous scrap compete metallurgically for the iron input to iron and steelmaking. Recognizing that certain technological and economic constraints dictate the current relative charge materials, there are still numerous opportunities for increasing the scrap proportion within those constraints.

Chief among the areas worthy of investigation, and detailed in the Technology section of the report, are: blast furnace tuyere injection of scrap granules or powder and increased use of properly sized scrap as part of the blast furnace burden; internal and external scrap preheating by electrical resistance heating; large line-frequency induction furnaces for superheating hot metal for BOF steelmaking; continuous charging of scrap to electric arc furnaces; and the use of higher-powered electric arc furnaces.

(3) Increase Artificial Demand Stimuli (G). Numerous suggestions have been made to promote the use of recycled products, such as tax incentives for using recycled materials or governmental purchasing policies favoring products made from recycled materials. Such policies would increase scrap demand. However, the effect and mechanisms for such proposals require detailed analysis.

While sounding simple in concept, the control and/or certification of "recycled content" for iron and steel products would be difficult in practice. Recycling certification would only help the ferrous solid waste problem if tied primarily to usage of obsolescent scrap. Because of the variety of sources and scrap yard/mill materials handling practices, the segregation and certification of product content would undoubtedly contribute to additional costs for both processor and user.

Careful analysis should be made of the mechanism for and cost/benefit from such proposals including their effect on other areas of the economy and nation.

(4) Increase Price Stability (SI-M). Scrap is bought and sold in a free market environment, resulting at times in extreme price volatility. While characteristic of this environment, and at times an aid to the movement of scrap, it nevertheless is a psychological and economic deterrent to increased scrap utilization.

A major influence is the lack of a continuing and steady market for scrap. Every attempt should be made by the scrap industry and its markets to provide quality product at profitable levels for both. A better understanding of complex price determinants and forecasting would help achieve stability. The implications of long-term purchase contracts should be analyzed in detail.

(5) Make In-Depth Analysis of Export Markets for Scrap (SI-G). A fluctuating market for ferrous scrap is the export market. Certain scrap surplus areas of this country are dependent on exports for scrap movement. However, many traditional foreign markets are becoming more self-sufficient in scrap and/or hot metal supply.

If our goal is to achieve increased recycling of American ferrous solid waste, and if domestic markets cannot effectively absorb all that could be made available, a detailed analysis of the export potential for excess supply should be undertaken. Export barriers should be identified, as should the effect of increased exports on our domestic supply and/or costs.

(6) Promote Interdependency and Involvement with Markets, Together With Emphasis on Marketing Versus Trading (SI-M). Too often, the scrap industry and its consuming markets deal at "arm's length". Yet each is mutually dependent on the other for their success. Greater

involvement and mutual understanding of each other's problems is required.

Obviously, "over night" changes are not possible. It is a "two way street". Increased participation by the scrap industry in technical associations is a move in this direction.

Increased emphasis should be placed on marketing scrap, e.g., promoting its value as a raw material source, providing technical assistance on its use, etc., in today's economic environment, rather than operating in the traditional trading atmosphere.

Development of New Markets

While the major opportunities for increased recycling of ferrous solid waste lie in increased participation in current markets, new market opportunities should be sought. It is therefore recommended that:

(1) Provide Preferential Financing/Tax Incentives for New Firms Based on Usage of Recycled Raw Materials or Products Containing High Recycled Content (G). Financial assistance for the establishment and initial operations of firms whose manufactured products make use of ferrous solid waste or its products, e.g., scrap-using mini mills may offer increased recycling potential. The effect on existing firms must also be considered.

(2) Expand Research to Find New Economic Uses for Ferrous Solid Waste (G). One example of such research is the Bureau of Mines' work on the reduction roasting of nonmagnetic taconites with automobile scrap. Others include the Bureau's research on the use of shredded automotive scrap for copper precipitation, and the use of light-gauge auto body scrap as a reinforcing core in concrete building blocks.

Detailed in this report's Technology section are two other areas worthy of consideration: development and execution of a preliminary experimental program on the use of relatively small scrap particles as reinforcement in concrete; and evaluation of the technical possibilities for the use of electrolytic processes for the conversion of scrap to usable form.

Improved Economics

Critical to increased recycling of ferrous solid waste is the development of lower-cost, higher-quality scrap products.

The following recommendations, if implemented, should assist in improving the economics of scrap products:

(1) Study Methods to Improve the Continuity of Ferrous Scrap Processing and Movement (SI-M). Continuous movement and processing of scrap for traditional cyclical markets is difficult to attain. Yet it is required for economic and efficient processing and increased removal of ferrous solid waste from our landscape.

Capital equipment investment is becoming of increasing importance to recycling of ferrous scrap. Continuous throughput of material is required to profitably utilize equipment. The average processing facility operates less than 48 hours/week--80 percent of all firms fall in this category. Even those with multi-million dollar capital investments seldom operate over 80 hours/week. While downtime for maintenance is obviously required for certain equipment, such as shredding systems, it is clearly indicated that the industry's capacity to produce is underutilized. Nonproductive time is costly.

A number of suggestions have been made to improve the continuity of operations, such as government stockpiling of processed material or collection subsidies in periods of low demand. Improved continuity should be studied in detail, to provide optimum processing efficiencies resulting in lower cost scrap and continual removal of ferrous solid waste from our landscape.

(2) Improve Logistics of Ferrous Solid Waste Collection, Assembling and Transportation (S-SI-G). More favorable logistic factors would obviously enhance the economic recycling of ferrous solid waste. Specific recommendations are included in a subsequent opportunity area--"Improved Logistics".

(3) Expand Research on Economic Separation and Marketing of Nonferrous Byproducts of Current Value (SI-E-G). Ferrous solid waste, as previously noted, contains large amounts of entrapped nonferrous materials, some of significant potential value if economically separated from the ferrous materials. For example, a recent Bureau of Mines study indicated that an average shredder discards approximately $400,000 worth of nonferrous values annually.(3)

Air classification systems are one approach to recovery; heavy media separation is another. Commercial development of an economic method should provide operating and financial benefits for the scrap processor, increasing the total value obtainable from ferrous solid waste, therefore increasing its utilization.

(4) Develop Appropriate Processing/Transportation Equipment (SI-E). Two areas of equipment development deserve continuing attention. One involves the development of portable equipment to assist in the logistics of ferrous solid waste. Examples developed to date are the auto flatteners, and mobile balers; other portable processing equipment may also offer some opportunities.

Another area is the development of processing equipment tailored for the medium and small processor. Scaled-down shredders and incinerators are two examples that have been already helpful.

(5) Study In-Depth the Effect of Depletion Allowances for Iron Ore on Scrap Recycling Rate (G). An apparent advantage of iron ore, the chief competitor to ferrous scrap, is the 15 percent depletion deduction from gross income in computing net taxable income for iron ore producers. No such advantage accrues to the scrap processor, and is, in effect, an incentive to use natural resources at the expense of ferrous scrap.

The effect of this advantage on recycling should be studied in detail. Remedial action to provide equity economics for scrap should be taken if warranted.

(6) Expand Research on Economic Disposal/Recycling of Residual Solid Waste Products (G). An increasing cost factor for the scrap processor and auto wrecker is the disposal of residual solid wastes, such as tires, glass, plastics, fibers and wood, and miscellaneous trash.

At least two approaches are possible: development of commercial disposal equipment, such as low-cost, pollution-free incinerators or development of new uses/recycling opportunities for the residue. Either would improve the recycling economics of ferrous solid waste.

Improved Scrap Quality

Due to the increasing complexity of consumer and industrial goods, major sources of ferrous solid waste, the separation of the ferrous content from residual impurities is becoming increasingly difficult. Substantial processing and upgrading is required. The following recommendations are aimed at alleviating the inherent problems:

(1) Develop Realistic Product Specifications (SI-M). In order to facilitate both processing and use of ferrous solid waste, the development of realistic product specifications is required. Quality scrap is required for today's sophisticated iron and steel products, but how good is good? The scrap industry in cooperation with its markets should attempt to further quantify chemical specifications for its products. Necessary to accomplish this goal are improved identification methods, improved measurement of scrap quality, and improved segregation methods at all levels of the scrap cycle--and price levels to support these improvements.

(2) Design End Products With Recycling in Mind (S-M). Today's emphasis on recycling is somewhat "after the fact". Products are designed for optimum service at lowest cost. This recommendation suggests a new dimension be included in product design--ease of recycling after being taken out of service. It further suggests some economic trade-off. To quote a recent study, "the materials and manufacturing techniques that have steadily reduced appliance prices have also steadily made it more difficult to separate the materials". (4) The effects on recycling and economic cost of alternate materials or placement for easy removal should be studied to see if improvements in scrap quality are possible at an appropriate cost/benefit level.

(3) Develop Improved Processing Equipment and Methods (SI-E-G).* While shredding equipment has made tremendous strides toward the lowering of residual content of obsolete scrap, further decreases are required. One approach, discussed in detail in the Technology section of this report, is cryogenic processing; other possibilities involve thermal or chemical removal of impurities. Continuous effort is required to provide improved product quality at competitive prices. Development of improved quality control methods, including identification and segregation, would help.

Improved Logistics

In order to achieve increased recycling of ferrous solid waste, its collection and movement must be greatly improved. Toward those ends, the following recommendations are made:

(1) Make an In-Depth Analysis of Transportation and its Recycling Role (G). Transportation is a major cost element affecting recycling of ferrous solid waste. Increased in-depth analysis should be conducted on the effect of its current economics and apparent inequity with iron ore on the recycling rate. Improved transportation methods and equipment should also be included, as should be the effect of establishing preferential freight rates for problem scrap, such as abandoned motor vehicles and steel containers.

(2) Make an In-Depth Analysis of Collection Methods and Economics (G). A major problem, tied closely to transportation, is the collection and assembling of ferrous solid waste on an economical basis. Particular emphasis should be given to that waste occurring in rural areas or in

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*Note from the publisher, the U.S. Environmental Protection Agency: The development of this kind of equipment is clearly the task of private industry because of the potential for profit benefits from such development.

other areas where scrap assembly for processing and use is different. Municipal solid waste separation is another facet of this problem. Provision of collection subsidies should be analyzed for their cost/benefit on increased recycling.

(3) Increase Funding for Demonstration Grants Aimed at Large Scale Recovery From Municipal Solid Waste (G).* Further detailed study is required on current operations and development of an optimum system for major metropolitan areas--and subsequent markets for the recovery products.

(4) Investigate the Feasibility of "Optimum Disposal and Recycling Facility" (SI-G). While there is merit in current specialized disposal and recycling activity, increased attention is being given to the effect and implications of central waste disposal, recycling centers, or environmental facilities parks. This approach envisions an optimum facility which accepts, processes, and uses waste materials at central locations.

Such facilities would undoubtedly be best managed and operated by the present ferrous scrap industry and other current recyclers, perhaps as subsidiary operations, and not by governmental units competing with current viable enterprises. This evaluation should be closely coordinated with the ferrous scrap industry, and should include such considerations as impact on the current recycling industry, increased market demand for recovered and processed materials, cost-benefit analysis, and alleviation of solid waste problems.

Minimized Legal Constraints

A number of apparent legal obstacles exist to more efficient movement of ferrous solid waste and operations of a scrap processing business. Two quasi-legal obstacles have previously been discussed, i.e., depletion allowances for competition, and transportation rate inequities. Recommendations for minimizing other legal constraints are as follows:

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*Note from the publisher, the U.S. Environmental Protection Agency: EPA has recently funded (in 1972) four projects to demonstrate various technological approaches to resource recovery. These projects, plus perhaps a few others, should be sufficient to demonstrate existing resource recovery technology.

(1) Promote Recognition by State and Local Government Units of the Distinct Function and Role of the Scrap Processor in the Economy and in Recycling (SI-G). Recognition should provide an adequate base for elimination of discriminatory licensing, zoning, and other restrictions. Adoption of realistic pollution controls should also be more easily gained.

This recognition will have to be promoted and earned by the scrap industry itself. Increased involvement with legislative authorities to promote this understanding is required, as is representation whenever possible on regulatory bodies affecting legislative matters and restrictions.

(2) Pursue Adoption of Uniform Titling Legislation for Motor Vehicles (G). A deterrent to efficient movement of motor vehicles to scrap processors involves various de-titling obstacles. Adoption of the model legislation, or some modification thereof, as proposed by the Council of State Governments and the Institute of Scrap Iron and Steel in 1967 would lessen this problem. A number of other policy alternatives for state and local governments on the abandoned vehicle problem are included in the Obsolete Motor Vehicle section of this report.

Improved Definition and Analysis of Scrap Situation

In order to adequately analyze problems and seek their solutions, the best possible definition and quantification of those problems is required. Basic data are provided by the Bureau of Mines' monthly Mineral Industry Surveys and annual Minerals Yearbook section on Iron and Steel Scrap, as well as publications by the Department of Commerce and others. In addition, a substantial data base was developed during the course of this study.

However, there still exists a need for more detailed, periodic statistical data on iron and steel scrap. For example, the second largest category of scrap by type listed in the Bureau of Mines' publication is "All Other Carbon Steel Scrap"; stainless and alloy scrap are shown only by grade totals; and scrap statistics by state have been eliminated beginning in 1971. The scrap market is quite cyclical, and better current data are required for good analysis.

It is therefore recommended in view of the above that:

(1) The Feasibility and Usefulness of Further Detailed Monthly Statistical Consumption Information Should Be Analyzed, and Provided If Warranted (G).

In addition, it is recommended that:

(2) Continue Periodic Regional and National Ferrous Scrap Demand/Supply Analysis on a Regular Basis (G). Dramatic changes affecting ferrous scrap consumption are occurring with increasing momentum in today's environmental, economic, and technological society. Continuous study and analysis of the situation are required if achievement of increased recycling and alleviation of solid waste problems is to be accomplished. In addition, the regional characteristics of these changes and their implications vary. The Bureau of Mines has provided an excellent base for analyzing these changes through a series of regional scrap surveys on generation, utilization, and consumption of iron and steel scrap. However, many of these are now dated.

Periodic (3 - 5 years) regional and national ferrous scrap analyses should be conducted on a continuing basis in order to improve the definition and understanding, identify new problems, and measure progress toward solutions.

(3) Undertake a Comprehensive Analysis/Census of the Available Supply of Ferrous Solid Waste Accumulation on a Regional and National Basis (G). If ferrous solid waste is to be considered a potentially valuable raw material resource, a better definition of its location, volume, and availability is required. The brief, cursory examination of the national availability in this report indicated a calculated amount approaching 750 million tons. What is a more accurate number? Where is this untapped reserve? What is its availability? In what forms does it exist? Answers to these and other questions should provide useful information for long-range programs aimed at maximizing this nation's supply of resources.

Increased Public Awareness of the Importance of Recycling and the Scrap Processor's Role

The scrap industry suffers from considerable public misunderstanding of its role in our society. Not always blameless, its public image, while improving, is still less than desirable. Recommendations to improve this situation are as follows:

(1) Expand the Current Commendable Public Relations Efforts of the Institute of Scrap Iron and Steel, Inc. (SI)

(2) Expand Community and School Education Efforts on Recycling and the Scrap Industry's Role (SI)

(3) Promote Mass Media Promotional Programs on Recycling by Individual Scrap Processing Firms, Regional Chapters, and Institute of Scrap Iron and Steel, and/or in Cooperation With Suppliers or Markets. (SI)

All of these recommendations are aimed at enabling the scrap industry to capitalize on this nation's ever increasing awareness of environmental problems and potential solutions, such as recycling. As the American Metal Market of April 20, 1971, proclaimed in an editorial, it is truly a "Golden Hour for Scrap." But it will not be achieved without the increasing positive action on the part of the ferrous scrap industry.

TABLE II-1. OPPORTUNITIES FOR INCREASED RECYCLING OF FERROUS SOLID WASTE AND RECOMMENDATIONS FOR ACHIEVEMENT

Opportunity For	Recommendations	By*	Relative Priority Rating**
• Increased Participation in Current Markets	(1) Provide greater technical service to markets	SI	17
	(2) Expand research, both technical and economic, on increasing the scrap proportion of the metallic charge	SI-M-G	17
	(3) Increase artificial demand stimuli, e.g., recycling incentives	G	16
	(4) Increase price stability	SI-M	14
	(5) Make in-depth analysis of export markets	SI-G	13
	(6) Increase involvement with markets and interdependency concept, including increased emphasis on marketing versus trading	SI-M	11
• Development of New Markets	(1) Provide preferential financing/tax incentives for new firms based on usage of recycled raw materials or products containing high recycled content	G	14
	(2) Expand research to find new economic uses for ferrous scrap, with particular emphasis on low quality scrap	G	12

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* SI - Ferrous scrap industry
M - Markets for scrap
S - Sources of scrap
G - Government
E - Equipment manufacturers

** The priority rating system is described in detail in Appendix C of this report. The priority number shown is to indicate the relative importance of recommendations within categories as a framework for action plans. 20 is the maximum achievable rating. The factors considered in assigning the rating were: (1) the extent that achievement of the recommendation's objective would have on increased recycling; (2) the feasibility of achieving the objective; and (3) the cost/benefit relationship of achievement. Scoring then was based on the effect, significant, moderate, or limited, that the recommendation would have on each category. The increased recycling category was given a maximum weight of 10, feasibility a maximum weight of 6, and cost/benefit a maximum weight of 4.

TABLE II-1. (Continued)

Opportunity For	Recommendations	By	Priority
● Improved Economics	(1) Study methods to improve the continuity of ferrous scrap processing and movement	SI-M	16
	(2) Improve logistics of ferrous solid waste collection, assembling, and transportation	S-SI-G	15
	(3) Expand research on economic separation and marketing of non-ferrous by-products of current value	SI-E-G	14
	(4) Develop appropriate processing/ transportation equipment	SI-E	13
	(5) Study in-depth the effect of depletion allowances for iron ore on scrap recycling rate	G	13
	(6) Expand research on economic disposal/recycling of residual solid waste products	G	11
● Improved Scrap Quality	(1) Develop realistic product specifications	SI-M	14
	(2) Design end products with recycling in mind	S-M	13
	(3) Develop improved processing equipment and techniques	SI-E-G*	12
● Improved Logistics	(1) Make an in-depth analysis of transportation and its recycling role, including effect of preferential freight rates for problem scrap	G	16
	(2) Make an in-depth analysis of collection methods and economics, including effect of collection subsidies	G	16
	(3) Demonstrate feasibility of large scale recovery	G**	13
	(4) Investigate feasibility of optimum disposal/recycling facilities	SI-G	12

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*See footnote, page 33

**See footnote, page 34

TABLE II-1. (Continued)

Opportunity For	Recommendations	BY	Priority
• Minimized Legal Constraints	(1) Promote recognition by state and local government units of the distinct function and role of the scrap processor in the economy and in recycling	SI-G	14
	(2) Pursue adoption of uniform titling legislation for motor vehicles	G	11
• Improved Definition and Analysis of Scrap Situation	(1) Evaluate feasibility and merit of more comprehensive monthly consumption statistical data	G	13
	(2) Initiate periodic regional and national scrap demand/supply analyses	G	13
	(3) Undertake a comprehensive analysis/census of ferrous solid waste accumulation	G	11
	(4) Prepare a current census of prompt industrial scrap generation	G	10
• Increased Public Awareness of the Importance of Recycling and the Scrap Processor's Role	(1) Expand the current commendable public relations efforts of the Institute of Scrap Iron and Steel, Inc.	SI	13
	(2) Expand community and school educational efforts on recycling and the scrap industry's role	SI	12
	(3) Promote mass media promotional programs on recycling by individual scrap processing firms, regional chapters, and Institute of Scrap Iron and Steel, and/or in cooperation with suppliers or markets	SI	11
	(4) Increase involvement of firms and its individual members in community affairs	SI	10

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CHAPTER III

ENVIRONMENTAL PERSPECTIVE

Mankind today faces the greatest environmental crisis in his history. While technology has given us a quantity of life which has brought us to the highest standard of living yet known, the quality of that life has been adversely affected. Current environmental problems affecting our aesthetic senses, economic costs, health, social welfare, and natural resources depletion, have made it quite evident that we live in a closed system and that continued exploitation of resources will result in both social and economic decay. While it is not within the scope of this study to analyze and recommend action concerning the totality of man and his environment, the problem which we are considering--recycling of ferrous solid waste--must be viewed as an integral part of a whole involving this complex matter of vital national concern. For it is within this context that iron and steel scrap has significant relevancy.

Preservation and protection of the environment have always been of concern to ecologists and conservationists. For many years, environmental action has been of a conservation nature, aimed primarily at preservation of natural resources, land usage, and animal wildlife. By mid-Twentieth Century, significant air and water pollution legislation had been enacted. But probably as in no other time in our nation's history did the environment become of such national, state, local and individual concern as in 1970. Individuals, civic groups, student activists and grade school children, business and industry, state and local officials, and the Federal Government at numerous levels became more aware and concerned than ever before as to what man has, is, and will do to his environment, and as a result, to himself.

On January 1, 1970, President Nixon signed the National Environmental Policy Act (PL 91-190), establishing for the first time a major national policy on the environment as a whole. In his State of the Union Address on January 22, 1970, he described the environment as a major concern to the American people in the decade of the seventies, second only to peace. He further cited environmental action as a major national goal in his Message on the Environment to the Congress, February 10, 1970. A prominent national news magazine(1) earlier this year proclaimed "Issue of the Year: The Environment." The quality of life, and not just its quantity, has indeed become a national issue.

The 1970's have ushered in the Age of Environmental Concern. Perhaps the Decade of Environmental Challenge is a title better suited to the tremendous task confronting the United States, and in fact, the entire world.

Environmental Problems

The nature and complexity of environmental problems and their ecosystems defy simple description. However, a broad outline of the types, causes, and effects of these problems can be developed from information presented by the President's Council on Environmental Quality, the major Federal policy-making group.

(1) Types of problems
    (a) Pollution
    (b) Land use
    (c) Natural Resources

(2) Causes of the problems
    (a) Misplaced economic incentives
    (b) Values
    (c) Population
    (d) Technology
    (e) Mobility
    (f) Limitations of government units
    (g) Information gaps

(3) Effects of problems
    (a) Health
    (b) Esthetics
    (c) Economic costs
    (d) Natural systems.

Qualification and quantification of these problems are detailed in the First Annual Report(2) by the Council, in what has been called the first time a nation has taken comprehensive stock of the quality of its surroundings. It successfully sought to describe the conditions of our environment, and to identify major trends, problems, actions underway and opportunities for the future. The problems are significant, and their solutions are crucial to the quality of our environment.

Air pollution, water pollution, and solid wastes are all forms of the same problem. Solid wastes, the environmental category into which nonrecycled ferrous scrap fits, is defined as the unwanted residue of society. It is estimated that 4.3 billion tons of solid waste were produced in the United States in 1969 (Table III-1). This is expected to increase to over 5 billion tons by 1980, and over 12 billion by 2000.

TABLE III-1. SOLID WASTE GENERATION, 1969

	Million Tons
Residential, Commercial and Institutional Wastes	250
Collected	(190)
Uncollected	(60)
Industrial Wastes	110
Mineral Wastes	1,700
Agricultural Wastes	2,280
TOTAL	4,340

Source: Environmental quality; the first annual report of the Council on Environmental Quality. Washington, U.S. Government Printing Office, Aug. 1970. p.107.

Of this total, only about 190 million tons, or 5 percent, was collected, amounting to 5 pounds per person per day. This is expected to increase to 8 pounds by 1980. Land disposal operations account for 90 percent (open dumps--77 percent, sanitary landfills - 23 percent), with incineration taking the bulk of the remainder. But the effectiveness of these operations is limited; a Federal survey of solid waste disposal practices found almost 95 percent of the land disposal and 75 percent of the incinerators unsatisfactory regarding public health, efficiency of operation, or protection of the environment.(3)

We are already spending $4.5 billion annually for handling this solid waste (80 percent for collection, 20 percent for disposal), and it has been estimated that another $4.2 billion is required for upgrading existing facilities alone.(3)

It is therefore apparent that the collection and disposal costs and problems, the aesthetic blight caused, and the under-utilization of this waste as a potential source for recycling into new products and therefore conserving our dwindling virgin raw materials, is increasing at an alarming rate. It is imperative that we reverse our environmental deterioration.

Environmental Action

There is a growing awareness and understanding by the American people of the nature of the threat to the environment and the interrelationships of environmental problems. This concern has led to action at all levels--private and public; local, state, and national. But the problems outlined above, their interrelationships, and their solutions are extremely complex. Conditions and needs vary throughout the nation. Air and water pollution can affect areas far from the polluting source, while solid wastes basically harm only the surrounding area.

Many of the problems are local by nature, and are best handled at that level. But local resources, jurisdiction, and efforts can result in an inefficient fragmented approach to the problems. By the same token, government environmental activity has grown piecemeal through the years. In addition, the financial requirements for facilities and development of improved technology are often beyond local capabilities.

The first major Federal laws dealing with environmental quality were the water pollution statutes of the late 1940's; those attempting control of air pollution were enacted in the 1950's. But it wasn't until 1965 that the enormous quantities of solid wastes being generated were recognized as a national problem, and the Solid Waste Disposal Act (PL 89-272) was passed. This legislation authorized establishment of the Bureau of Solid Waste Management (within the Department of Health, Education and Welfare) to perform research, development, and demonstrations of new and improved solid waste technology and provided grants for state and area-wide solid waste management planning, technical assistance, and personnel training funds. This recognition of the problem and the contributions made by the Bureau, and its successor, the Office of Solid Waste Management Programs, show significant environmental action by the government.

Since 1965, other significant Federal legislation relative to solid wastes include:

The National Environmental Policy Act of 1969 (PL 91-190), January 1, 1970;
The Environmental Quality Improvement Act of 1970 (PL 91-224), Apr 3, 1970; and
The Resource Recovery Act of 1970 (PL 91-521), October 26, 1970.

It is appropriate that the Federal Government, due to the complexity and implications of diverse environmental efforts, and as noted in the previous legislation, should take a leadership role in the attack on improving environmental quality. In 1970, major steps were taken with the establishment of the Council on Environmental Quality, in the Executive Office of the President, as the chief Federal policy group, and the Environmental Protection Agency, an independent agency, as the chief Federal enforcement group. These two organizations, complementing and reinforcing each other's mission, should provide the means for comprehensive, integrated, coordinated, and concentrated Federal action on environmental quality. The EPA has absorbed five programs formerly scattered throughout various Federal agencies: the water quality program of the Federal Water Quality Administration from the Department of Interior; the air quality program of the National Air Pollution Control Administration from the Department of Health, Education and Welfare; the solid waste programs of the Bureau of Solid Waste Management, Bureau of Water Hygiene, and portions of the Bureau of Radiological Health, all from HEW; some pesticide work of the Food and Drug Administration (HEW), Department of Agriculture, and Department of Interior; and certain radiation functions of the Atomic Energy Commission and the Federal Radiation Council.

The main thrust of the President's Message on the Environment to Congress in February, 1971, concerned air and water pollution and land use. However, two key points were made that could have potential significant effect on solid waste and on the scrap industry. The recommended tax on sulfur oxide emissions and leaded gasolines is a step toward the basic philosophy that the costs of pollution should be included in the price of the product. Disposal taxes on autos and other products is akin to this approach. The second point encourages Federal purchase of recycled materials, specifically paper. It suggested that this program will be expanded to other products with recycled content. This approach could have the effect of increasing the scrap proportion for iron and steelmaking.

Another significant government activity of major importance to solid wastes, and in particular, ferrous solid wastes, is the work of the Bureau of Mines in the Department of Interior. Their efforts and accomplishments, through both in-house research and research grants, have made many contributions to the utilization technology of ferrous scrap.

In addition to these government agencies, significant contributions toward an understanding and solution of environmental quality problems as they relate to ferrous scrap are being made by other national environmental quality groups, such as the National Industrial Pollution Control Council (NIPCC) established by the President, Executive Order 11523 on April 9, 1971. This is a top-level advisory group from business and industry, consisting of over 200 chief executives. Their major function is to offer advice on programs of industry that relate to environmental quality to the President and the Council on Environmental Quality through the Secretary of Commerce. Another is the National Center for Resource Recovery, Inc. recently established and funded by various materials and container producers with the emphasis on container recycling. Of particular importance is the recent establishment of the National Commission on Materials Policy, set up to study and develop a national materials policy to enhance environmental quality and conserve resources.

There is also significant environmental action taking place on the state and local levels. Establishment of environmental quality authorities on regional, state, county and local bases is becoming wide spread. Solid waste management is getting a far more detailed analysis today than ever before due to the increasing lack of disposal facilities and mounting disposal costs. State and local legislation aimed at nonreturnable containers is under consideration in numerous areas. Business and industry, civic associations, youth groups, educational and research institutions, sportsmen groups, ecologists, garden clubs, individuals--the list of those concerned is endless.

It is therefore evident that this nation and its people are concerned about the quality of our environment. They are poised for action, and action is taking place. But due to the many diverse considerations and ecosystems bearing on a solution to the problems we have created for ourselves, many questions remain to be answered regarding what to do and how fast, how to do it, who should do it, how much must be done, and who will pay.

Economic Implications of Environmental Quality

The economic cost of improving the quality of our environment is beyond easy or precise determination, as is the task of quantifying the damage already done. The cost of no improvement is also hard to measure in dollars, although the qualitative social costs are well known. Basic decisions as to how much improvement is needed and how fast it must be done need definition. Nevertheless, the economic cost to date has been of great magnitude; the results less than outstanding. And the costs are only beginning. The Second Annual Report of the Council of Environmental Quality, issued in August, 1971, estimated the cost of abatement pollution control for cleaning up the environment would total $105.2 billion during 1970-1975, at an annual rate nearly double that of 1970. Of the total annual rate of $18.3 billion by 1975, air-pollution control will account for 26 percent, water 31 percent, and solid waste 43 percent. Industry will be required to pay 42 percent of the total, more than double its present rate.(4)

Our economic system, which has given us the high standard of living we know today, is profit motivated. Of the total capital investment made by American industry in 1970, an amount approaching 10 percent went for pollution control, an investment on which zero economic return is made and which normally would be used to increase productivity and thereby to lower costs. And this does not consider the additional operating costs that industry must absorb because of controls. In the primary markets for ferrous solid waste, i.e., the iron and steel industries, a recent survey placed pollution expenses at 7.5 percent of total manufacturing costs.(5)

Other economic problems occur. Varying pollution standards may put one manufacturer at a disadvantage with another based simply on location. The Securities and Exchange Commission is already developing guidelines that would require publicly held companies to disclose the full financial impact of their antipollution efforts or problems. Numerous facilities are faced with the economic decision of discontinuing operations versus installation of pollution control equipment beyond their financial resources.

The steel industry, the primary market for ferrous scrap had invested \$1 billion by the end of 1970.(6) Annual costs of maintaining and operating pollution control equipment is estimated at 10 percent of orginal construction cost. A recent study noted that the steel industry, in order to implement the required increases in air pollution control levels by 1976, would need an additional initial investment of at least \$981 million, with added annual costs averaging about \$507 million. Gray iron foundries would be even harder hit, as the study indicated that less than half their annual control costs could be recovered through increased prices. The estimates included an initial \$317 million, with \$108 million annual operating costs. This would force many of the already marginal firms out of business.(7) Facing environmental improvement versus economic crisis will become more prevalent.

The NIPCC, in a major report issued in February, 1971, stated that "rising public concern over pollution has resulted in actions at some levels of government which are incompatible with the economic health of our society". The chief executive of a major steel producer, the primary market for ferrous solid waste, stated in the same report that "the pollution controls required by regulation laws are straining the industry's financial resources to the extent that it is difficult to keep up with just those commitments required by law. Thus the opportunity for genuine voluntary commitments (for other improvements) are distinctly limited."(8) It is therefore imperative that there be mutual understanding and commitment by all concerned--government, public and industry--if progress is to be made.

Environmental policies are not only a dilemma and concern on the domestic scene, but in international trade as well. Any nation whose anti-pollution standards are higher than another is put at a competitive cost disadvantage in world trade on this basis alone. A common approach is required to minimize the side effects of pollution control on international trade and investment. An attempt to establish global guidelines for dealing with environmental pollution and management of natural resources will be made at the United Nations Conference on the Human Environment in Stockholm in 1972. Once again, the economics of improving environmental quality is a major factor in policy formation.

Improving the environment goes beyond just the costs of pollution control; certain economic and production dislocations are potentially at stake. A renowned ecologist recently asserted that "ecologically-faulty technology is so massively embedded in the nation's system of production that any effort to change it is bound to cause very serious economic disruptions."(9) He claims, for example, that if all the sulfur dioxide were recaptured from the nation's smokestacks that the reclaimed sulfur would be sufficient to nearly wipe out the present sulfur-producing industry.

These are just a few of the economic implications of an improved environmental quality. Perhaps a redefinition of profit in both social and economic contexts is required. "Who shall pay" is still the big question, although in the end, we will all pay. Numerous suggestions have been made such as tax incentives, disposal taxes, subsidies, low cost-long term loans, and discriminatory purchasing policies. There is no easy or satisfactory solution to all concerned at this point in time.

But the economic implications of an improved environment, while difficult to measure, are great. No longer may the most efficient manufacturing process be used if by doing so the environment is impaired. The result of environmental protection will undoubtedly be to increase the cost of goods and services as more net investment is channeled into pollution control, and part of this increase will have to be absorbed by industry. Profits will be maximized, but subject to environmental constraints. Current sources of pollution must be eliminated; in addition, we are also faced with the prospect of cleaning up past contamination. The cost of ignoring the problem will, in the long run, be far more costly to the economic growth of this nation. Certainly long-term growth would be retarded. With a growing population and reduced economic growth, a decrease in our standard of living as traditionally defined would result. Therefore, how far and how fast we progress in the direction of environmental quality improvement balances delicately on achieving, within our socio-politico framework, an economic cost/environmental benefit equilibrium.

Solid Waste Alternatives

Six basic alternatives exist for solid waste management. They are to:

(1) Continue polluting, which is obviously unacceptable due to both environmental and economic considerations

(2) Limit use of current materials contributing to pollution, which could have severe economic consequences

(3) Make greater use of biodegradable materials, which has some merit but is limited in their use due to economic and technological factors

(4) Develop new uses for solid waste in its present form, which offers limited applications.

(5) Improve disposal of waste through improved economic and sanitary methods, which has certain merits, but is a waste of potential resources.

(6) Recycle as a great a portion of the solid waste as possible, the most promising alternative, both environmentally and economically.

Recycling the conversion and reuse of discarded products in the production of new, offers the best potential alternative for improving both our environmental and economic climates. While a totally "closed system," one in which all waste is recycled for useful and productive purposes, is not feasible, greater utilization than at present is necessary. Five basic reasons exist for the "why" of economic recycling of solid waste. They are:

(1) Alleviation of mounting solid waste problems and costs.
(2) Conservation of natural resources.
(3) Use of an economic raw material source.
(4) Improving aesthetic and health considerations.
(5) Avoidance of economic dislocations within processing and supplying industries.

Ferrous solid waste, while representing a minor portion of total municipal and industrial waste, is nevertheless a highly visible and contributing factor. Defined as those portions of discarded iron and steel materials and the ferrous components of discarded products which are not collected and processed into ferrous scrap and subsequently recycled into new iron and steel products, it represents an under-utilization of potentially valuable resource. It is intimately bound to the total solid waste problem; its allevation should therefore have positive consequences for solid waste management.

References-- Chapter III

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CHAPTER IV

FERROUS SOLID WASTE

Ferrous solid waste is an integral part of our total solid waste problem. It is defined as those portions of discarded iron and steel materials and the ferrous components of discarded products which are not collected and processed into iron and steel scrap by the ferrous scrap industry. While it amounts to less than 10 percent of the total municipal and industrial solid waste generated annually, it nevertheless is a highly visible portion, in such forms as abandoned motor vehicles, steel cans, obsolete consumer major appliances, construction debris, abandoned agricultural implements, and numerous other products littering our landscape. Since it is intimately bound to the total problems and their solutions, alleviation of this part of the problem will have wide-spread positive consequences for all solid waste.

Iron and steel (ferrous) scrap, the product of value obtained from potential ferrous solid waste and vital to the production of new iron and steel, originates from three basic sources. It represents 50 percent of the total ferrous raw material charge to production of raw steel and iron and steel castings. Home, or mill revert, scrap, accounting for about 60 percent of total domestic scrap consumption, is the ferrous waste product generated during iron and steel production, such as ingot croppings, sheet trimmings, and foundry gates and risers. The other sources are known collectively as purchased scrap, the products manufactured and marketed by the ferrous scrap industry from potential ferrous solid waste. There are two basic types, named for their sources: prompt industrial scrap, accounting for 20-25 percent, is the ferrous waste product generated during fabrication of mill products into industrial and consumer products by metalworking firms, such as stampings, cuttings, and turnings; and obsolete scrap, accounting for 15-20 percent, which comes from fabricated products that have been discarded, such as obsolete motor vehicles, railroad car dismantling, demolition projects, and other obsolete consumer and industrial products.

Sources of Iron and Steel Scrap

Iron and steel are the primary materials used in the United States economy. Over a hundred million tons of these materials are produced and consumed each year. However, at various stages in the processing or use of these products, they lose their utility and/or value and become potentially a major solid waste problem. The ferrous scrap industry transforms this waste into value.

Ferrous solid wastes are a particularly difficult problem because of the extensive and varied use of iron and steel in both industrial and consumer products. Furthermore, these products have broad consumption patterns and are distributed throughout the country. With the growth of the economy, the expansion of the population and affluence of the consumer, and the changes in other socio-economic factors, the volume of ferrous waste materials has increased. It has come from both traditional sources and from entirely new sources in terms of the types of original products, characteristics of materials and their geographic location. Particularly significant is the greater volume of light-weight, flat-rolled steel materials generated by the fabrication and use of industrial equipment and consumer durables.

Millions of tons of ferrous waste materials never are recycled to the iron and steel industries.* This represents losses to the economy in terms of the failure to reuse available resources, to improve the environment, and to increase the supply of materials to the scrap industry.

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*Battelle estimates that over 30 million tons in 1970 alone became available for recycling, but accumulated as ferrous solid waste. See Table IV-26, page 116.

The sources of ferrous waste materials vary as to type, form, condition, geographic location, and quantities involved. By strict definition, ferrous waste materials are referred to as iron and steel scrap only after they have been put in a form and quality to meet specifications for sale to the iron and steel industries. Many of the materials generated within the iron and steel industries and other metal working industries meet the specifications with only a minimum of processing and preparation. However, millions of tons of other ferrous waste materials obtained from sources such as demolition activities and disposal of consumer durables require considerable handling and processing to be put into forms and qualities for sale. Several types of consumer durables such as automobiles and appliances, agricultural equipment, and mine equipment in particular, present logistical problems due to their wide geographic distribution and a need to upgrade their qualities to meet the specifications as scrap.

Traditionally, iron and steel scrap has been identified as consisting of three general types, named for their source. These include home, prompt industrial, and obsolete scrap. Over half of the ferrous scrap that is consumed by the iron and steel industries is home scrap. Frequently, this material is described as revert scrap since it is consumed by the same companies that originate it. Another common source of ferrous waste materials is referred to as prompt industrial scrap. These materials are generated throughout the operation of metal fabricating firms in the manufacture of products containing iron and steel materials. These are very desirable materials for use as scrap and most of them are recycled directly to the iron and steel industries because of known composition. Finally ferrous waste materials originate from industrial and consumer products that have lost their usefulness and have been disposed of by their owners. After they have been processed and prepared for sale they are referred to as obsolescent scrap. However, because of the wide geographic distribution of these materials, millions of tons are not gathered and processed, and therefore become ferrous solid waste.

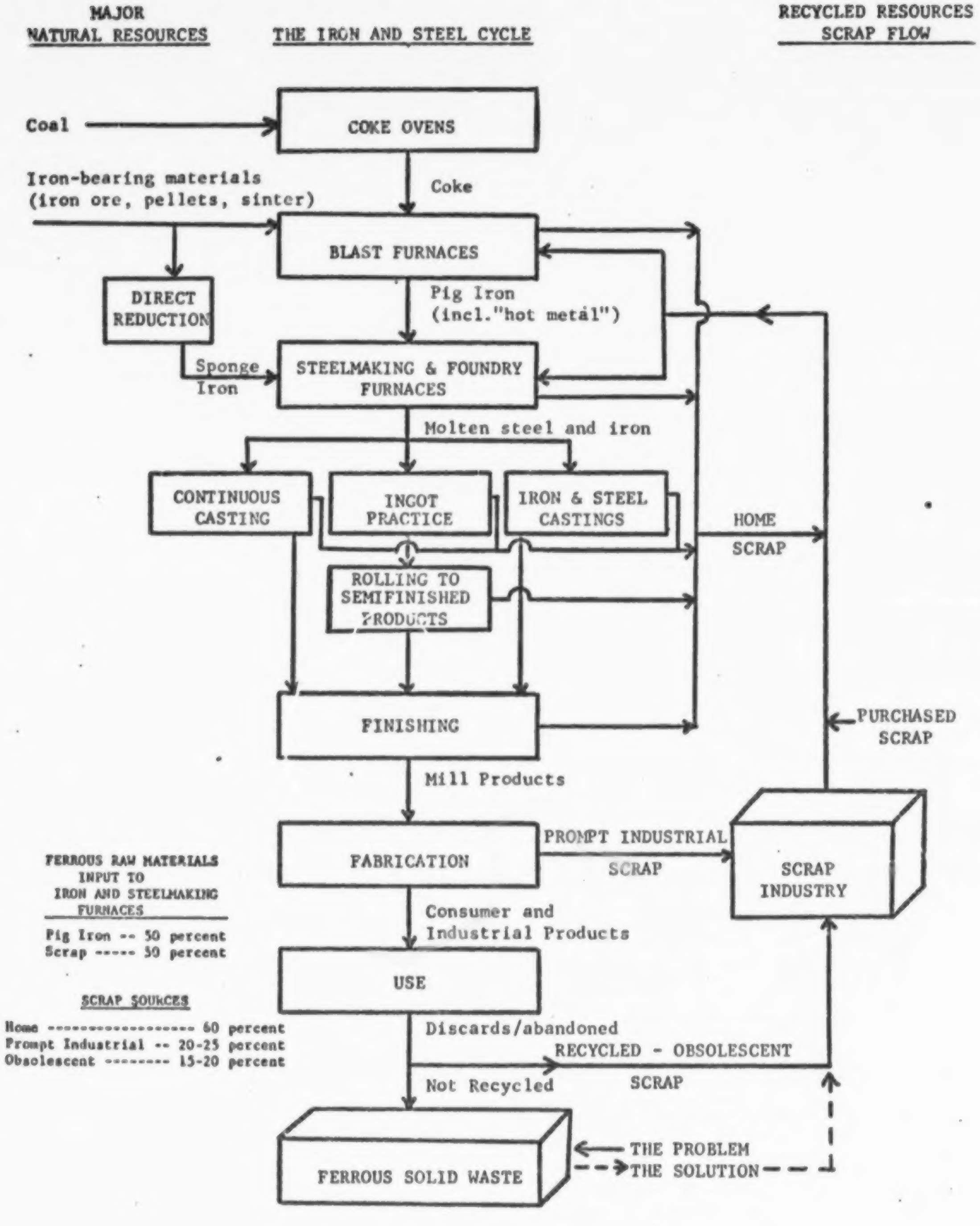

MAJOR NATURAL RESOURCES
THE IRON AND STEEL CYCLE
RECYCLED RESOURCES SCRAP FLOW
Coal
COKE OVENS
Coke
Iron-bearing materials (iron ore, pellets, sinter)
BLAST FURNACES
DIRECT REDUCTION
Pig Iron (incl."hot metal")
Sponge Iron
STEELMAKING & FOUNDRY FURNACES
Molten steel and iron
CONTINUOUS CASTING
INGOT PRACTICE
IRON & STEEL CASTINGS
HOME SCRAP
ROLLING TO SEMIFINISHED PRODUCTS
FINISHING
PURCHASED SCRAP
Mill Products
FABRICATION
PROMPT INDUSTRIAL SCRAP
SCRAP INDUSTRY
FERROUS RAW MATERIALS INPUT TO IRON AND STEELMAKING FURNACES
Pig Iron -- 50 percent
Scrap ----- 50 percent
Consumer and Industrial Products
USE
SCRAP SOURCES
Home ------------------ 60 percent
Prompt Industrial -- 20-25 percent
Obsolescent -------- 15-20 percent
Discards/abandoned
RECYCLED - OBSOLESCENT SCRAP
Not Recycled
FERROUS SOLID WASTE
THE PROBLEM
THE SOLUTION

FIGURE IV-1. THE IRON AND STEEL CYCLE AND FERROUS SOLID WASTE

Figure IV-1 is a schematic diagram of the types and flow of ferrous scrap and waste materials from their sources to the iron and steel consumers of scrap. This diagram depicts the recycling of home scrap generated by the steel and foundry industries to their own iron and steel melting shops. It also traces the flow of finished iron and steel products and castings to fabricators of industrial and consumer products. From these fabricating processes, prompt industrial scrap is recycled either directly through scrap brokers or indirectly through scrap processors to the steel and foundry industries. Shipments of basic and fabricated iron and steel products to final consumers result in the generation of obsolescent scrap depending on the life cycles of those products. The obsolescent scrap that is recycled is shown to flow through scrap processors and scrap brokers to steel companies and iron and steel foundries. However, potential obsolete scrap that is not recycled is shown separately as ferrous solid waste with no return for consumption.

Home Scrap

Steel companies and iron and steel foundries generate scrap from the melting operations and finishing processes on their products. While nearly all this scrap can be recycled without any extensive processing or preparation, some must be cut or otherwise prepared and therefore could be considered ferrous waste materials. However, for the purpose of this study, since it is generally not recycled through any scrap industry facilities, it can all be considered home scrap.

This type of scrap is generated from several sources within the steel and foundry industries. The origin for most of it is from ingot and bloom scrappings; billet, pipe, and bar ends; "spills" and "runnings" from hot metal;

plate shearings; sheet trimmings; foundry gates and risers; rejected materials; obsolete equipment; and scale. The amount of home scrap is generally related to the melting and finishing production of steel companies and iron and steel foundries. As production changes, the volume of home scrap also fluctuates. In addition, the amount of scrap generated is affected by the types and specifications of products, the practices and equipment used in melting and rolling, and other technological changes. Bad heats and rollings of new and widely diversified products tend to increase rejected materials. However, at the same time, greater use of computers, control, and sensing equipment has improved melting and finishing processes. More importantly, the introduction of continuous casting of slabs and billets direct from steelmaking furnaces and thereby by passing traditional ingot practice has contributed to the production yield of companies but at the same time reduces the amount of home scrap available. While the use of ingots generates 25 to 30 percent scrap, continuous cast slabs result in only 10 percent and billets in less than 5 percent. The potential for continuous casting is estimated at about 80 percent of total steel production. Capacity was estimated at 10 percent in 1970 and is projected to climb to 20 percent by 1980.

The foundry industry has also experienced changes in the quantities of home scrap that are generated. This industry produces more home scrap per unit of melted iron and steel than the steel industry and the quality of its home scrap is more consistent. In general, the percentage yields and volumes of home scrap generated by the three types of foundries are as follows:

Type of Foundry	Percent of Product Yield	Percent of Home Scrap
Malleable	40	60
Steel	50	50
Gray Iron	60	40

Source: Cleveland, Gray and Ductile Iron Founders' Society.

Adoption of improved technology, equipment, and casting practices have increased the yields and reduced the amount of home scrap in many foundries. At the same time, quality and scrap control programs have increased the quantity of home scrap available.

The quantities of home scrap generated within the steel and foundry industries are closely related to the production and shipments. The total quantity of home scrap produced through both the steel industry and iron foundries was 44.7 million net tons in 1963. The volume increased to 55.5 million tons in 1966 as the production of both industries expanded. However, with a decline in the output of steel and castings in 1967, the volume of home scrap generated dropped to 52.3 million tons and then climbed to 56.3 million tons in 1969 (Table IV-1).

TABLE IV-1. HOME SCRAP GENERATED BY INDUSTRY AND TYPES OF MANUFACTURER, 1960-1970

(thousand short tons)

Year	Steel Industry	Iron Foundries*	Steel Foundries	Total
1960	N.A.	N.A.	N.A.	39,632
1961	N.A.	N.A.	N.A.	38,475
1962	N.A.	N.A.	N.A.	40,644
1963	37,638	5,664	1,353	44,655
1964	44,774	5,992	1,496	52,262
1965	46,978	6,650	1,585	55,213
1966	46,920	6,930	1,613	55,463
1967	44,312	6,532	1,468	52,312
1968	46,639	5,740	1,166	53,545
1969	49,257	5,814	1,216	56,287
1970	46,394	5,149	1,032	52,575

*Includes miscellaneous products

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1960-1970. (10 v.)

Sources of home scrap are primarily either recirculating, i.e., home plant, or recycled iron and steel scrap, or obsolete, i.e., molds, stools, machinery and buildings. In 1967, the last year in which sources of home scrap were identified, the following occurred (Table IV-2).

TABLE IV-2. SOURCES OF HOME SCRAP, 1967

Industry	Recirculating		Obsolete		Other		Total	
	Million Net Tons	%	Million Net Tons	%	Million Net Tons	%	Million Net Tons	%
Steel	38.6	87	3.4	8	2.3	5	44.3	100
Iron foundries	6.3	97	0.1	1	0.1	1	6.5	100
Steel foundries	1.4	98	Negligible		Negligible		1.5	100

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1967. p.631.

The geographic distribution of home scrap generation by state during 1969 is shown in Figure IV-2 and Table IV-3, based on the Bureau of Census Geographic Divisions. The generation of home scrap is primarily in the East North Central and Middle Atlantic states of Illinois, Indiana, Ohio, Michigan, and Pennsylvania. These five states accounted for 39.8 million tons or approximately 70 percent of the home scrap in 1969. Six other states including Maryland, New York, Alabama, Texas, California, and West Virginia generated 11.5 million tons, or 20 percent of the total. The balance of 4.7 million tons was distributed amoung several states throughout the country.

Purchased Scrap

As previously noted, there are two categories of purchased scrap--prompt industrial and obsolescent.

Prompt Industrial Scrap. Metalworking firms generate prompt industrial scrap in their fabrication of both industrial and consumer products. These materials

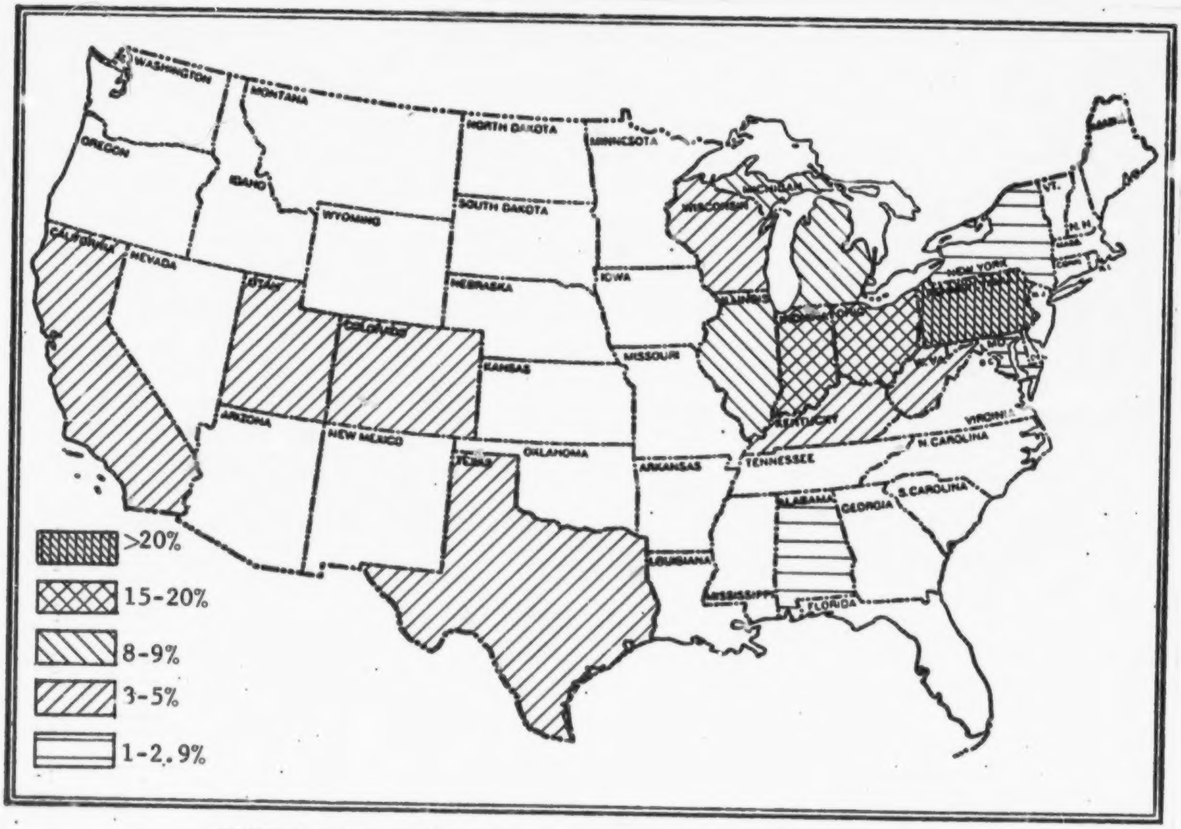

WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
VT.
N.H.
NEW YORK
WYOMING
CALIFORNIA
NEVADA
UTAH
COLORADO
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
MD
W.VA
KANSAS
MISSOURI
KENTUCKY
VIRGINIA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
N. CAROLINA
S. CAROLINA
TEXAS
ALABAMA
GEORGIA
LOUISIANA
MISSISSIPPI
FLORIDA
>20%
15-20%
8-9%
3-5%
1-2.9%

FIGURE IV-2. HOME SCRAP GENERATION BY STATE, 1969
(percent of U.S. total)

TABLE IV-3. HOME SCRAP GENERATION BY STATE, 1969

(net tons)

State	Mill Revert Produced
Alabama	2,016,331
Arizona	3,120
California	1,452,822
Connecticut	68,088
Georgia	3,223
Illinois	4,893,851
Indiana	8,337,184
Iowa	175,401
Kansas	41,049
Kentucky	844,842
Maryland	2,803,845
Massachusetts	61,282
Michigan	4,481,757
Minnesota	245,004
Missouri	280,787
New Jersey	148,137
New York	2,629,039
North Carolina	56,503
Ohio	9,564,793
Oklahoma	51,650
Oregon	52,711
Pennsylvania	12,523,999
Rhode Island	47,823
South Carolina	28,648
Tennessee	190,033
Texas	1,587,408
Utah	844,956
Vermont	8,814
Virginia	194,971
Washington	149,836
West Virginia	1,012,134
Wisconsin	533,395
Undistributed	715,107
TOTAL	56,048,543

Source: Yearbook. 31st ed. Washington, Institute of Scrap Iron and Steel, 1970. p.42.

are described as prompt industrial scrap because of their source, characteristics, and the relatively short channel of distribution back to the steel and foundry industries for reuse. With the development and growth of the metalworking industries over the past century, standard procedures have been established for the recycling of these materials.

Prompt industrial scrap originates from several sources within metalworking companies depending on the equipment and fabricating processes used. Description of the types of scrap generated are related to the specific fabricating operation involved. These include clips, turnings, borings, punchings, stampings, trimmings, and drillings. By strict definition, some of these byproducts of metalworking are ferrous waste materials depending on whether they are processed and otherwise prepared for reuse as scrap. Considerable quantities of prompt industrial scrap are shipped in loose forms or pieces and described as No. 1 busheling, machine shop turnings, machine shop turnings and iron borings, shoveling turnings, shoveling and iron borings, or iron borings. These materials are classified as scrap when they are shipped in essentially the same form in which they were produced in a plant. However, other materials are classified as scrap only after they have been segregated; cleaned, cut, or aggregated into briquettes or bundles. Subsequently, these materials are shipped as No. 1 bundles, No. 2 bundles, bundled No. 1 steel, bundled No. 2 steel, electric furnace bundles, briquetted iron borings, or briquetted steel turnings. Many of these materials originate from light-weight sheet steel. In addition, large quantities of heavier materials are shipped as No. 1 heavy melting steel; No. 2 heavy melting steel, and other classifications.

Prompt industrial scrap is one of the two major categories of purchased scrap used by the steel and foundry industries. Moreover, it is one of the most desirable types of materials because of generally known composition and condition, in addition to containing relatively few contaminates. In addition to its consistent quality, the steady operation of metalworking plants provides reliable sources and volumes of this type of scrap. Most large metal fabricating plants have established procedures and equipment for segregating, baling, or briquetting these materials for resue. Some firms generate many rail cars of prompt industrial scrap each week for direct shipment to steel companies and iron and steel foundries. However, the scrap from thousands of smaller metalworking plants is collected, processed, and shipped indirectly through firms in the scrap industry. In both cases, scrap brokers may participate in the commercial aspects of the transaction.

The volume of prompt industrial scrap generated is closely related to the level of production activites within the several metalworking industries. The geographic location of plants, types of product design, substitution of competitive materials, and ratio of scrap to finished components are also important in considering the quantities of prompt industrial scrap that are available. Unfortunately, there is limited information on the effects of these factors of supply.

Current accurate information on the prompt industrial scrap generation rate is unavailable. The most comprehensive study on this subject was made for 1954 generation rates by the Business and Defense Service Administration.* Using survey methodology, the scrap ratios and quantities generated were developed for the majority of iron and steel consuming industries by type of scrap (heavy melting, bundles, cast iron, and all other) and by geographic areas. The scrap generation ratio for all iron and steel products was pegged at 19.4 percent.

*Business and Defense Services Administration. Industrial scrap generation, iron and steel, copper, aluminum. Washington, U.S. Government Printing Office, 1957. 35 p.

The subsequent studies have generally approximated that average. For purposes of this study, the average has been reduced to 17.5 percent, based on a 20 percent generation rate for steel mill products and 5 percent for ferrous castings. This reduction was based on limited sampling during the course of this study, analysis of increasing production efficiencies, and consideration of improved iron and steel materials as slightly offsetting changes in product mix and tightening product specifications. This is only an estimate depending on changes in production methods, iron and steel product mix, and emphasis on production controls and economics, the rate will vary from year to year.

Based on the above prompt industrial generation ratios, an estimate of the volume generated from 1960 - 1970 is shown in Table IV-4.

TABLE IV-4. ESTIMATED GENERATION OF PROMPT INDUSTRIAL SCRAP, 1960-1970
(Thousand Net Tons)

Year	Steel Mill Products Domestic Consumption	Prompt Industrial Scrap Generation(1)	Iron and Steel Castings Domestic Consumption	Prompt Industrial Scrap Generation(2)	Total Prompt Industrial Scrap Generation
1960	71,531	14,306	13,775	689	14,995
1961	67,299	13,460	12,722	636	14,096
1962	72,639	14,528	13,824	691	15,219
1963	78,777	15,755	15,076	754	16,509
1964	87,943	17,589	17,093	855	18,444
1965	100,553	20,111	18,719	936	21,047
1966	99,024	19,805	18,867	943	20,748
1967	93,667	18,733	17,128	856	19,589
1968	107,646	21,529	17,718	886	22,415
1969	102,682	20,536	18,843	942	21,478
1970	97,109	19,422	16,327	816	20,238

(1) 20% of steel mill products domestic consumption.
(2) 5% of iron and steel castings domestic consumption.

Source: (Domestic consumption). Annual statistical report. New York, American Iron and Steel Institute, 1964, 1966, and 1970.

No current accurate information is available on generation of prompt industrial scrap by geographic area. The BDSA study cited previously included such information, but numerous changes in the output and location of metalworking plants have occurred since 1954. A rough estimate, however, has been prepared, considering metalworking employment, type of product, and estimated iron and steel product shipments and consumption (Figure IV-3).

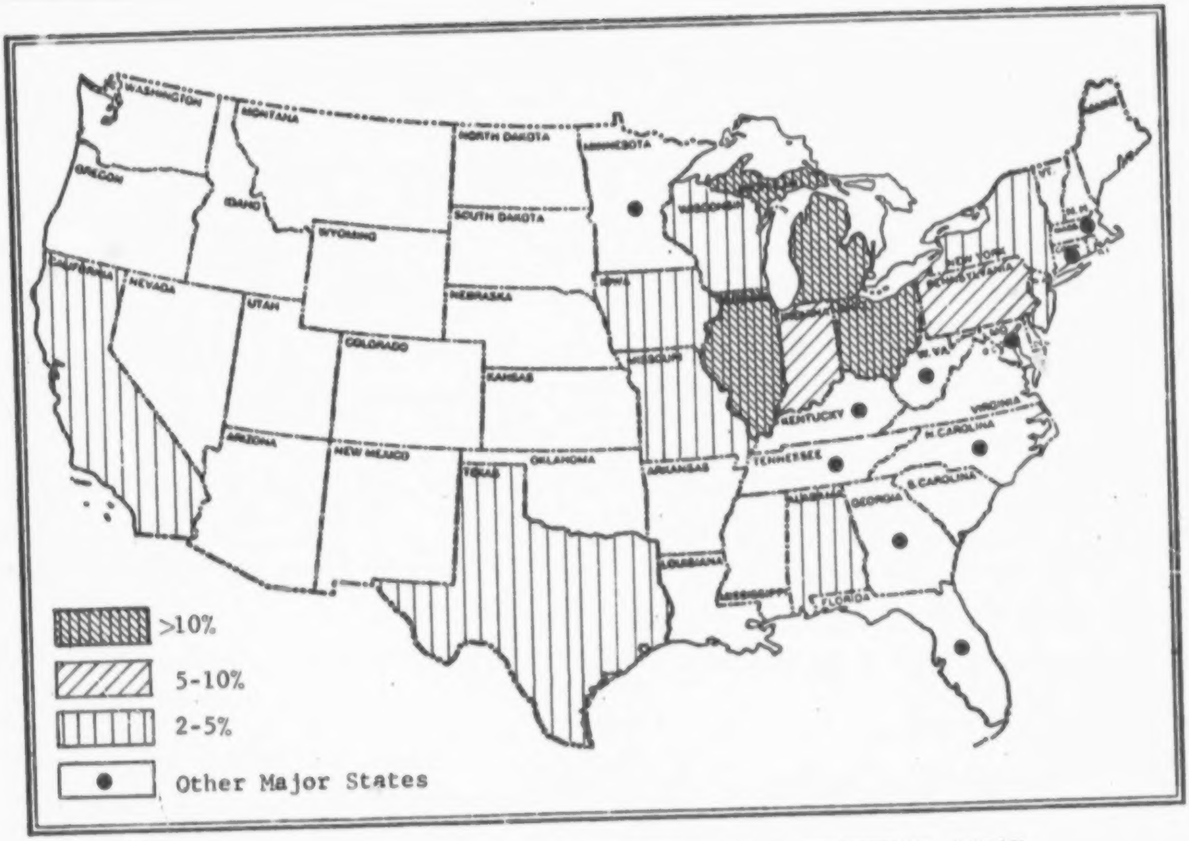

WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
WISCONSIN
VT.
N.H.
NEW YORK
PENNSYLVANIA
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
COLORADO
KANSAS
MISSOURI
W.VA.
MD.
KENTUCKY
VIRGINIA
N.CAROLINA
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
TENNESSEE
S.CAROLINA
ALABAMA
GEORGIA
LOUISIANA
MISSISSIPPI
FLORIDA
>10%
5-10%
2-5%
● Other Major States

FIGURE IV-3. ESTIMATED PROMPT INDUSTRIAL SCRAP GENERATION BY MAJOR STATES, 1969 (percent of U.S. total)

Source: Battelle-Columbus estimates.

Generation is heavily concentrated in the East North Central and Middle Atlantic regions, estimated at over 50 percent of the total. The major states are Michigan, Ohio, Illinois, and Pennsylvania. These areas, being the centers of iron and steelmaking, provide a ready market. However, some minor regional imbalance of supply and demand does occur.

The availability of prompt industrial scrap has a direct bearing on requirements for obsolescent scrap. It is therefore a recommendation of this report that a new survey of prompt industrial scrap generation be conducted, so that ferrous solid waste planning may be enhanced.

Obsolescent Scrap. The second major source of purchased iron and steel scrap consists of both industrial and consumer products that have been disposed of by their final users. Typically, these ferrous waste materials are described as obsolescent scrap after they have been processed and prepared for reuse. However, for purposes of determining the sources for these types of materials, the term obsolescent scrap is ambiguous. While obsolescence is a general reason for disposal of industrial and consumer products, there are several specific causes for their obsolescence.

Obsolescence may occur through deterioration of products until they have only a marginal economic value. This deterioration may be caused by length of service, the manner in which the products were used, or the environment in which they were operated. Frequently, products are disposed of at various points in their life cycle due to failure of operation or because of extensive damage. In both instances, depending on the costs of repairs, the products may have only a marginal value. Other reasons for the interruption or reduction of normal life cycles would include the development of new products, changes in operation or uses of facilities, equipment or other property, and several indirect factors such as the use of salt on highways, vehicle inspection laws, displacement of buildings in urban development and for highways, tax credit on capital investment, and general economic conditions.

More importantly, these ferrous waste materials are scattered throughout the country, in various physical conditions, and have different levels of economic value. The majority of these materials include automobiles, trucks, appliances, rail equipment, machinery, ships, structural components, and containers. Some of these products or their components are simple in configuration, contain only one known material, are in good condition, and exist in readily accessible locations. As such, they are very desirable materials for reuse as scrap and have relatively high economic value. Examples of the sources of these materials would include structural components of buildings, ships, railroad equipment, industrial machinery and some agricultural machinery. These types of materials are recycled as scrap with little difficulty.

However, there are millions of tons of other ferrous waste materials contained in automobiles, appliances, and containers that are only partially recycled as scrap. Because of their design, the presence of nonferrous metals and other materials, or their remote location, these types of materials have either little or no economic value. Depending on the price and demand, most automobiles within the economical shipping distance from markets for scrap are recycled. However, most containers, the remaining autos and appliances in these areas, and nearly all materials in remote urban and rural areas are never recovered. In the more accessible locations, many automobiles and apliances are disposed of in isolated locations that make it too difficult to remove them, or, as with most containers, their specific locations are unknown. In addition to similar problems in the more remote areas, the limited value of the materials make it uneconomical to attempt to collect them for recycling. Therefore, only a limited quantity of these types of materials is recoverd for scrap. There are no accurate published data on recycling of obsolescent scrap. Certain types of scrap can be assumed to have obsolescent scrap as their source, e.g., No. 2 bundles, shredded scrap, railroad scrap, and significant portions of export scrap. However, a rough estimate can be derived from subtracting home scrap and prompt industrial scrap from total scrap purchases (Table IV-5).

TABLE IV-5. ESTIMATED GENERATION AND RECYCLING OF OBSOLESCENT SCRAP, 1960-1970
(thousand tons)

Year	Total Domestic Receipts of Purchased Scrap	Prompt Industrial Scrap	Estimated Obsolescent Scrap	Obsolescent, Percent of Total
1960	26,095	14,995	11,100	42.5
1961	25,305	14,096	11,209	44.3
1962	25,284	15,219	10,065	39.8
1963	29,432	16,509	12,923	43.9
1964	31,831	18,444	13,387	42.1
1965	35,804	21,047	14,757	41.2
1966	36,671	20,748	15,923	43.4
1967	32,654	19,589	13,065	40.1
1968	33,587	22,415	11,172	33.3
1969	36,929	21,478	15,451	41.8
1970	34,148	20,238	13,910	40.7

Source: (Receipts--1960-1969). Yearbook. 31st ed. Washington, Institute of Scrap Iron and Steel, 1970. p.33. All else, Battelle-Columbus estimates.

It is cautioned that these figures are only an approximation. All prompt industrial scrap is not recycled, although the amount not recycled is probably less than 10 percent. The same is true of home scrap. Some losses occur. In addition, inventory changes on a year-to-year basis further distort the tonnage.

It is interesting to note that these estimates are in sharp contrast to the relative importance of prompt industrial and obsolete scrap indicated in previous studies. The BDSA study estimated prompt industrial and obsolete at 16 percent and 24 percent respectively of total scrap. These estimates as can be seen in Table IV-8 reverse the order. While recognizing these estimates as only calculated, they are generally confirmed by the Extensive Survey conducted in conjunction with this study. The survey indicated that 46 percent of the establishments contacted received over 50 percent of their scrap volume from industrial sources; an additional 25 percent received 26 - 50 percent of their raw material from industrial sources. While obviously some industrial source material could be considered obsolete, e.g., machinery, buildings, etc., most of it would be prompt industrial.

There is no published information on the geographic distribution of ferrous waste materials. Because of the diverse types of materials and their wide distribution, it is difficult to obtain accurate data or to develop an index related to the sources of these materials. Except for a complete census of the actual generation of these materials, the best general indicator is the relative distribution of the population adjusted for historical and recent socio-economic activities. Therefore, considering the types of original products involved, the states with the largest populations and urban centers, those with major historical economic activities, and areas involved with extensive urban redevelopment could be expected to generate large quantities of ferrous waste materials. By the same token, regions and states with rural-based economies also generate considerable quantities of obsolete materials due to their increasing affluence, shipment of used automobiles, appliances, and other products into these areas for secondary use, and the deterioration of products related to the socio-economic activities of these areas. Two major factors affecting the collection and processing of ferrous waste materials in these more remote regions and states are the absence of scrap processing facilities in the areas and the uneconomical shipping distances to markets for the obsolete scrap.

Table IV-6 describes Battelle's estimate of the generation and recycling of obsolescent scrap by geographic areas during 1969. As indicated above, this distribution is based on the percent of adjusted population related to socio-economic estimates determined for each state and region. Based on this approach, it is estimated the largest volumes of obsolete ferrous materials are generated and recycled in the East North Central, Middle Atlantic, South Atlantic, and Pacific regions. While the major industrial states in the midwest are estimated to generate the largest total as a group, the largest individual producing states are New York and California with nearly 2.0 million tons each. Based on this approach, the more urbanized and industrialized states such as Ohio, Illinois, Michigan, New York, New Jersey, Massachusetts, Texas, California, and others generate obsolete ferrous materials at proportionately higher rates than other states. On the other hand, the states of Maine, New Hampshire, Vermont, Mississippi, Arkansas, North Dakota, South Dakota, Montana, Wyoming, and Nevada are examples of those areas that generate relatively smaller quantities.(Figure IV-4).

There are many factors that will affect the generation and recycling of obsolescent scrap during the next fifteen years. In general, the major influence will be the basic demand for scrap over and above that capable of home and prompt industrial supply. However, this demand will also be affected by other factors such as the quality of processed scrap, the relative costs of collecting, processing, and shipping the materials, and the changes in prices paid for these types of materials.

TABLE IV-6. ESTIMATED OBSOLESCENT SCRAP GENERATION AND RECYCLING BY CENSUS REGIONS, 1969

Census Region	Distribution (percent)
New England	6.0
Middle Atlantic	20.0
East North Central	22.0
West North Central	8.0
South Atlantic	14.0
East South Central	5.0
West South Central	9.0
Mountain	3.0
Pacific	13.0
	100.0

Source: Battelle-Columbus estimate.

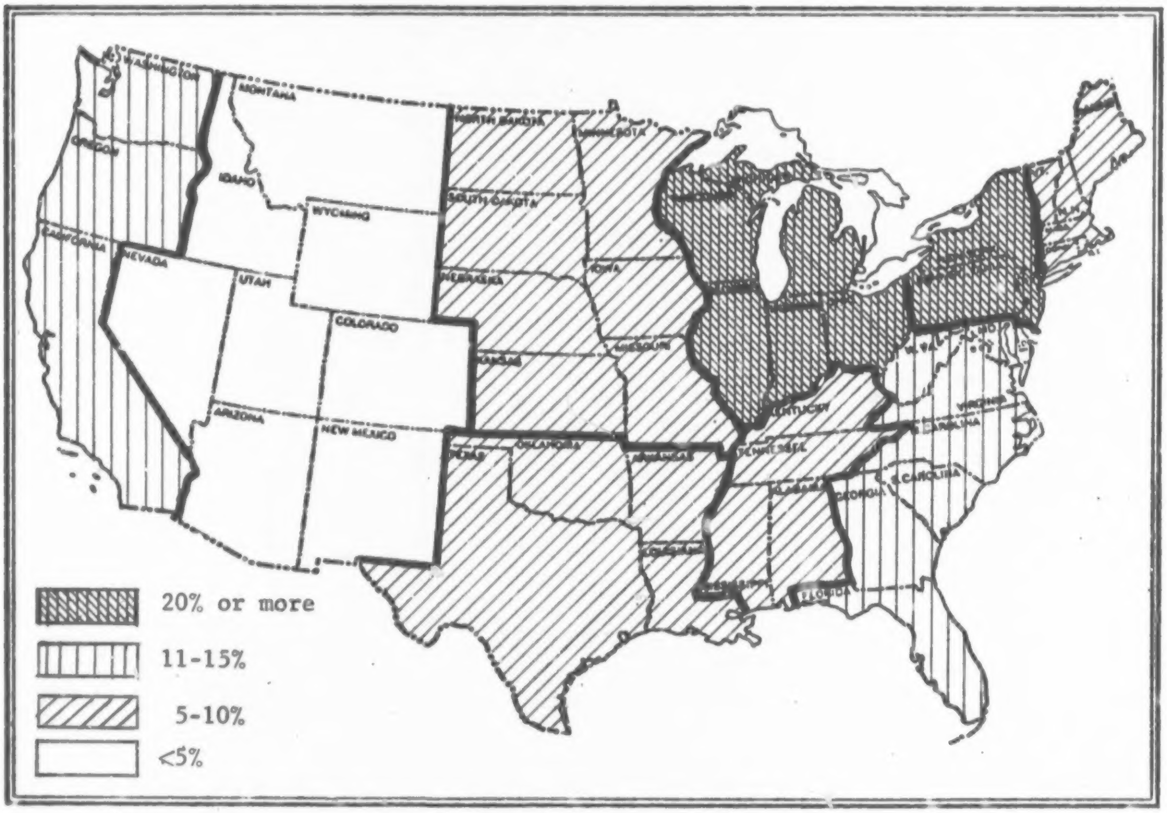

WASHINGTON
MONTANA
OREGON
IDAHO
WYOMING
CALIFORNIA
NEVADA
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
NEBRASKA
IOWA
KANSAS
MISSOURI
OKLAHOMA
TEXAS
ARKANSAS
LOUISIANA
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
S.CAROLINA
CAROLINA
VIRGINIA
FLORIDA
20% or more
11-15%
5-10%
<5%

FIGURE IV-4. ESTIMATED OBSOLESCENT SCRAP GENERATION AND RECYCLING BY CENSUS REGIONS, 1969 (percent of U.S. total)

Summary Statistics

Based on the above analysis, a summary of the various sources of ferrous scrap appears in Tables IV-7 and IV-8.

TABLE IV-7. SOURCES OF FERROUS SCRAP, 1960-1970
(thousand net tons)

Year	Domestic Scrap Consumption	Scrap Availability	Home Scrap	Purchased Scrap	Purchased Scrap: Prompt Industrial	Purchased Scrap: Obsolescent
1960	66,469	65,727	39,632	26,095	14,995	11,100
1961	64,327	63,780	38,475	25,305	14,096	11,209
1962	66,160	65,928	40,644	25,284	15,219	10,065
1963	74,621	74,087	44,655	29,432	16,509	12,923
1964	84,626	84,093	52,262	31,831	18,444	13,387
1965	90,359	91,017	55,213	35,804	21,047	14,757
1966	91,583	92,134	55,463	36,671	20,748	15,923
1967	85,361	84,966	52,312	32,654	19,589	13,065
1968	87,060	87,132	53,545	33,587	22,415	11,172
1969	94,816	93,216	56,287	36,929	21,478	15,451
1970	85,559	86,723	52,575	34,148	20,238	13,910

Sources: Yearbook. 31st ed. Washington, Institute of Scrap Iron and Steel, 1970, for all figures except prompt industrial and obsolescent scrap which are Battelle-Columbus estimates. Consumption may exceed availability in certain years due to inventory changes.

TABLE IV-8. SOURCES OF FERROUS SCRAP, 1960-1970
(percentage distribution)

Year	Total Scrap Availability = 100: Home, percent	Purchased, percent	Prompt Industrial percent	Obsolescent percent	Purchased Scrap = 100: Prompt Industrial, percent	Obsolescent percent
1960	60.3	39.7	22.8	16.9	57.5	42.5
1961	60.3	39.7	22.1	17.6	55.7	44.3
1962	61.6	38.4	23.1	15.3	60.2	39.8
1963	60.3	39.7	22.3	17.4	56.1	43.9
1964	62.1	37.9	21.9	16.0	57.9	42.1
1965	60.7	39.3	23.1	16.2	58.8	41.2
1966	60.2	39.8	22.5	17.3	56.6	43.4
1967	61.6	38.4	23.1	15.3	59.1	40.1
1968	61.5	38.5	25.7	12.8	66.7	33.3
1969	60.4	39.6	23.0	16.6	58.2	41.8
1970	60.6	39.4	23.3	15.7	59.3	40.7

Sources: Yearbook, Institute of Scrap Iron and Steel, 1970, and Battelle-Columbus estimates.

The ferrous castings industry relies to a much greater extent than the steel industry on purchased scrap for its scrap requirements, approximately 60 percent purchased and 40 percent produced. For the steel industry, purchased amounts to about 35 percent. In total purchased scrap approximates about 40 percent of total domestic scrap consumption (Table IV-9).

TABLE IV-9. SCRAP SOURCES BY INDUSTRY, PURCHASED VS. PRODUCED, 1968-1969 (thousand net tons)

	Purchased	Produced	Total Available Supply	Percent Purchased of Total Supply
1968				
Manufacturers of steel ingots and castings	23,500	46,639	70,139	33.5
Manufacturers of steel castings	1,834	1,166	3,000	61.1
Iron foundries and miscellaneous users	8,253	5,740	13,993	59.0
1969				
Manfacturers of steel ingots and castings	25,894	49,257	75,151	34.5
Manufacturers of steel castings	2,045	1,216	3,261	62.7
Iron foundries and miscellaneous users	8,990	5,814	14,804	60.7

Source: (Produced). Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1968, p.619, and 1969, p.609. (Purchased). Receipts minus shipments from above source.

The geographic distribution of total scrap consumption is heavily concentrated in the Middle Atlantic and East North Central states, consuming 73 percent of total scrap consumption in 1969. Five states alone, Pennsylvania, Ohio, Indiana, Michigan, and Illinois, consumed 68 percent. Continued domination of scrap consumption in these areas is expected (Figure IV-5 and Table IV-10).

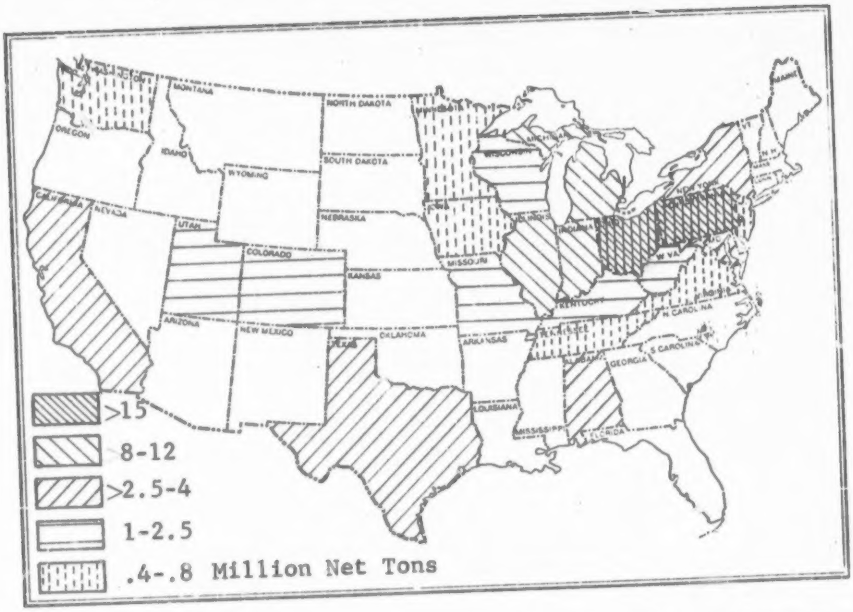

WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
WISCONSIN
MICHIGAN
NEW YORK
MAINE
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
INDIANA
COLORADO
KANSAS
MISSOURI
KENTUCKY
W VA
N CAROLINA
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
ARKANSAS
TENNESSEE
ALABAMA
GEORGIA
S CAROLINA
LOUISIANA
MISSISSIPPI
FLORIDA
>15
8-12
>2.5-4
1-2.5
.4-.8 Million Net Tons

FIGURE IV-5. CONSUMPTION OF IRON AND STEEL SCRAP AND PIG IRON BY STATE 1969.

TABLE IV-10. CONSUMPTION OF IRON AND STEEL SCRAP AND PIG IRON[1] BY STATES, By Type of Manufacturers in 1969 (Thousand short tons)

	Steel ingots and castings[2]		Steel castings[3]		Iron foundries and miscellaneous users		Total[4]	
	Scrap	Pig Iron	Scrap	Pig Iron	Scrap	Pig Iron	Scrap	Pig Iron
Alabama	2,479	3,599	136	(5)	948	675	3,599	4,274
Arizona	W	---	W	---	W	---	W	---
Arkansas . . .	---	---	W	---	---	---	W	---
California . .	2,528	2,284	125	3	285	80	2,938	2,367
Colorado. . . .	W	W	W	(5)	W	(5)	W	W
Connecticut . .	73	---	3	(5)	83	20	159	20
Delaware . . .	W	---	W	W	---	---	W	W
Florida	W	---	---	---	W	W	W	W
Georgia	W	---	W	(5)	W	10	W	10
Illinois . . .	7,175	6,814	497	13	1,262	391	8,934	7,218
Indiana	10,362	12,668	162	1	793	194	11,317	12,863
Iowa.	---	---	58	---	552	38	610	38
Kansas.	---	---	87	(5)	22	3	109	3
Kentucky. . . .	1,284	W	---	---	242	W	1,526	W
Louisiana . . .	---	---	13	W	---	---	13	W
Maine	---	---	---	---	W	W	W	W
Maryland. . . .	3,243	W	25	---	98	W	3,366	W
Massachusetts .	---	---	9	(5)	101	27	110	27
Michigan. . . .	5,610	7,102	120	1	3,283	648	9,013	7,751
Minnesota . . .	338	446	54	1	89	37	481	484
Mississippi . .	W	---	---	---	---	---	W	---
Missouri. . . .	843	1	120	1	95	18	1,058	20
Montana	---	---	---	---	W	(5)	W	(5)
Nebraska. . . .	---	---	W	W	W	---	W	W
Nevada.	---	---	W	W	---	---	W	W
New Hampshire .	---	---	W	---	W	W	W	W
New Jersey. . .	250	---	45	---	419	70	714	70
New York. . . .	3,118	5,869	153	12	703	84	3,974	5,965
North Carolina.	W	---	---	---	W	W	W	W
Ohio.	13,856	15,401	445	31	2,247	642	16,548	16,074
Oklahoma. . . .	W	---	W	(5)	W	W	W	W
Oregon.	139	---	60	(5)	9	1	208	1
Pennsylvania. .	17,422	23,082	416	34	767	131	18,605	23,247
Rhode Island. .	77	---	---	---	50	10	127	10
South Carolina.	---	---	---	---	51	W	51	W
Tennessee . . .	---	---	20	2	454	182	474	184
Texas	2,535	117	58	(5)	601	85	3,194	202
Utah.	W	W	W	W	W	W	W	W
Vermont	---	---	---	---	23	7	23	7
Virginia. . . .	---	---	174	W	459	W	633	W
Washington. . .	554	W	18	W	10	---	582	W
West Virginia .	1,647	W	31	W	47	W	1,725	W
Wisconsin . . .	---	---	305	7	654	157	959	164
Undistributed .	3,109	13,379	208	4	449	253	3,766	13,636
U.S. Total[4] .	76,641	90,761	3,342	113	14,833	3,761	94,816	94,635

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes molton pig iron used for ingot molds and direct castings.

[2] Includes only those castings made by companies producing steel ingots.

[3] Excludes companies that produce both steel ingots and castings.

[4] Data may not add to totals shown due to independent rounding.

[5] Less than 1/2 unit.

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1969. p.607.

Ferrous Solid Waste

The preceding information on sources of scrap provided background leading to the crux of the problem of ferrous solid waste. Ferrous solid waste is defined as iron and steel products and materials that have served their intended purposes and are therefore available for other uses. The proportion that is processed and recycled is iron and steel scrap, a useful material of value; that which is discarded becomes ferrous solid waste, to date a useless material of no value. There are many examples of ferrous solid waste, such as abandoned motor vehicles, discarded consumer white goods, agricultural equipment blighting our landscape, refuse from urban demolition projects, and steel cans in municipal solid waste and littering our roadsides. The types are varied; the actual locations unknown. However, the problems associated with each have certain common characteristics, such as logistic problems, quality considerations for effective recycling, and market outlets. Therefore, an examination follows of three specific types, junked motor vehicles, steel cans, and discarded major household appliances. Each is prominent in this nation's current environmental thinking. The problems and potential solutions associated with each are characteristic of the vast majority of ferrous solid waste.

Junked Motor Vehicles

The largest tonnage market for iron and steel products, and subsequently the major source of purchased iron and steel scrap is the automotive industry. about 20 percent of all steel products and gray iron castings, and 40 percent of malleable iron castings are consumed by this market. Even higher consumption would be indicated if steel shipments out of service centers were included (Table IV-11).

TABLE IV-11. AUTOMOTIVE CONSUMPTION OF IRON AND STEEL PRODUCTS

	Percent of Total Shipments			
	1960	1963	1966	1969
Steel	20.5	22.4	20.0	19.5
Gray and Ductile Iron	18.6	19.4	16.4	17.1
Malleable Iron	70.4	56.6	44.9	41.7

Source: Automobile Manufacturers Association, Inc., Automobile Facts and Figures, 1971, 1968, 1965, and 1962 editions.

Significant amounts of prompt industrial scrap are generated during the production of motor vehicles. The probable steel scrap generation range is 25 to 35 percent; with iron castings, the range is from 5 to 10 percent of purchases. Most of this material enters the scrap cycle promptly and presents little problem for ferrous solid waste management. It is segregated at the automotive plants, and therefore commands a premium price due to its known composition.

However, the greatest amount of potential scrap from this source enters the cycle as obsolescent scrap, the product of junked motor vehicles. Annual scrappage of vehicles approaches 8 million units, making available over 10 million tons of obsolescent scrap each year (Figure IV-6).

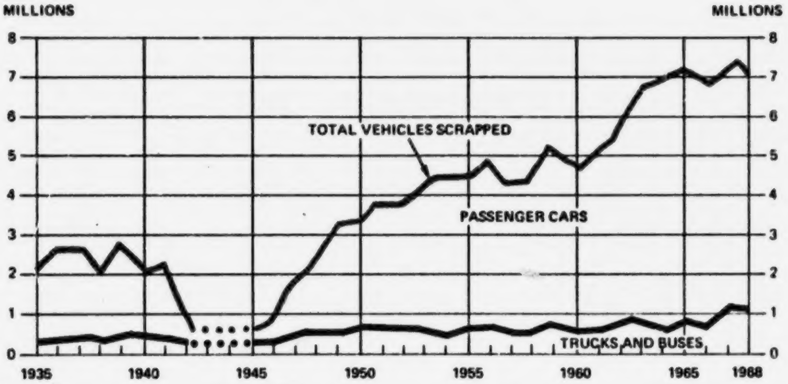


FIGURE IV-6. ANNUAL MOTOR VEHICLE SCRAPPAGE, 1935-1968.

Source: 1971. Automobile facts and figures. [Detroit], Automobile Manufacturers Association. p.24.

Based on current trends, the number scrapped annually is expected to climb to 10 million units by 1975, 11.5 million by 1980, and 13 million by 1985. Autos account for about 85 percent of the total, with trucks and buses the remaining 15 percent.

The geographical distribution of vehicle scrappage correlates closely with new motor vehicle registrations, as would be expected. (Table IV-12).

TABLE IV-12

ESTIMATED NUMBER OF AUTOS AND TRUCKS JUNKED IN THE UNITED STATES BY STATE IN 1968

(Thousands of Vehicles)

State Division	Total Junked	Percent of U.S. Total
NEW ENGLAND		
Maine	22	0.3
New Hampshire	33	0.5
Vermont	15	0.2
Massachusetts	168	2.4
Rhode Island	27	0.4
Connecticut	89	1.2
Division Total	354	5.0
MIDDLE ATLANTIC		
New York	685	9.8
New Jersey	271	3.8
Pennsylvania	392	5.6
Division Total	1348	19.2
EAST NORTH CENTRAL		
Ohio	503	7.2
Indiana	199	2.9
Illinois	493	7.0
Michigan	493	7.0
Wisconsin	149	2.1
Division Total	1837	26.2
WEST NORTH CENTRAL		
Minnesota	116	1.7
Iowa	103	1.5
Missouri	124	1.8
North Dakota	23	0.3
South Dakota	33	0.5
Nebraska	61	0.8
Kansas	71	1.0
Division Total	531	7.6
SOUTH ATLANTIC		
Delaware	41	.6
Maryland	144	2.0
District of Col.	24	0.3
Virginia	118	1.7
West Virginia	41	0.6
North Carolina	85	1.2
South Carolina	55	0.8
Georgia	89	1.3
Florida	187	2.7
Division Total	784	11.2
EAST SOUTH CENTRAL		
Kentucky	83	1.1
Tennessee	165	2.4
Alabama	83	1.2
Mississippi	50	0.7
Division Total	381	5.4
WEST SOUTH CENTRAL		
Arkansas	56	0.8
Louisiana	155	2.2
Oklahoma	79	1.1
Texas	361	5.2
Division Total	651	9.3
MOUNTAIN		
Montana	28	0.4
Idaho	23	0.3
Wyoming	21	0.3
Colorado	58	0.8
New Mexico	34	0.5
Arizona	27	0.4
Utah	26	0.4
Nevada	13	0.2
Division Total	230	3.3
PACIFIC		
Washington	21	0.3
Oregon	74	1.1
California	789	11.2
Alaska	[1]	[2]
Hawaii	18	0.2
Division Total	902	12.8
U.S. TOTAL	7018	100.0

1. Less than 1,000
2. Less than 0.1%

Note: These figures include vehicles junked, abandoned or otherwise taken out of service in 1968. They should not be confused with table which refers to vehicles taken in for dismantling. (Table 3)

Source: Estimated by BDSA on basis of junk auto trends, 1968 sales estimates and 1967-1968 registration data.

Scrap Age, 27(2):229, Feb. 1970.

A simplified flow chart of obsolete motor vehicle movement appears below.

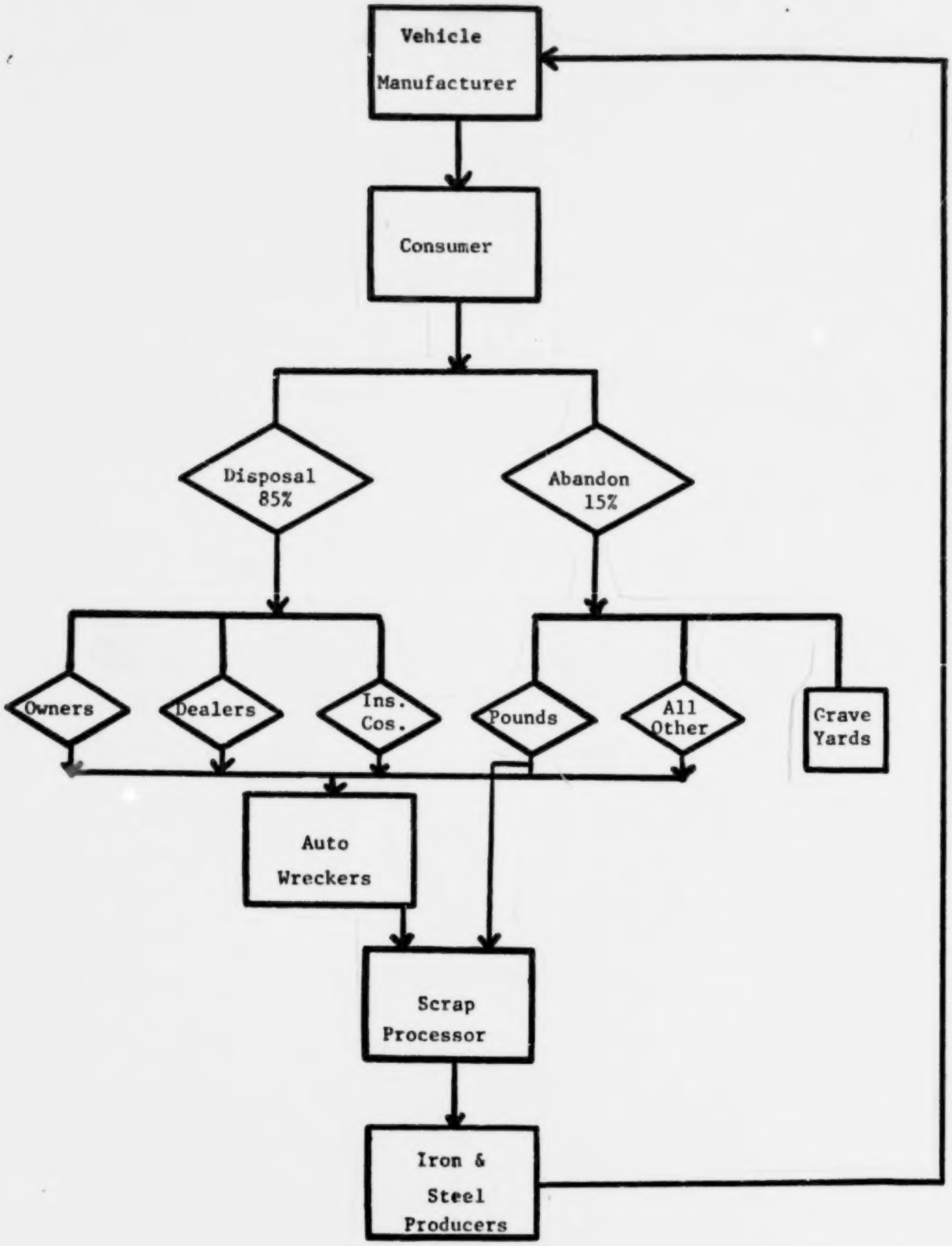
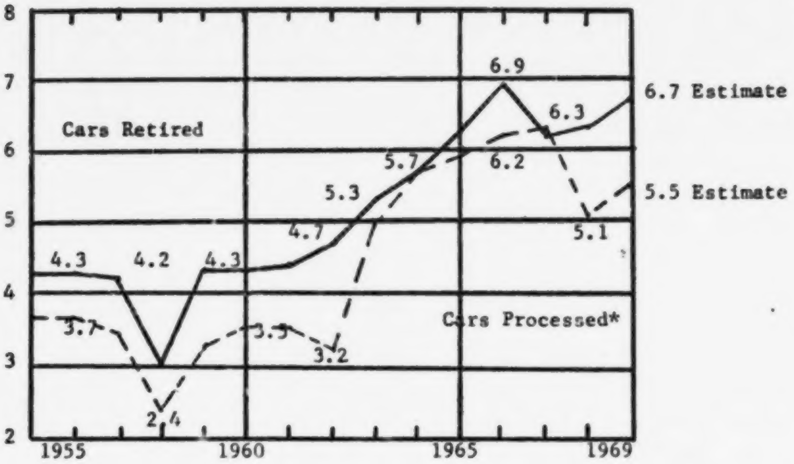

Vehicle Manufacturer
Consumer
Disposal 85%
Abandon 15%
Owners
Dealers
Ins. Cos.
Pounds
All Other
Grave Yards
Auto Wreckers
Scrap Processor
Iron & Steel Producers

FIGURE IV-7 OBSOLETE MOTOR VEHICLES FLOW CHART

As can be seen from the flow chart, the two key elements in vehicle flow are the auto wrecker and the scrap processor. Both industries and their methods of operation will be covered in detail later in this report.

If obsolete vehicles were to move smoothly, as indicated on the chart, little problem for solid waste management would be encountered. (A notable exception is the disposal of nonmarketable items from the wrecker and processor operations, such as the nonmetallics of rubber, plastics, and glass. Research is being conducted on their utilization, but as yet, no significant recycling opportunities have been developed. These materials account for slightly over 10 percent of total vehicle weight.)

But of even greater importance is the need for increased recycling of the marketable 90 percent materials in obsolete vehicles. A significant portion of the retired vehicles, estimated at 15 percent, do not enter the scrap cycle directly through disposal as indicated in the flow chart, but are abandoned. They are a blight on our landscape and their removal costs, even in urban areas, often exceed the value received. Most eventually enter the cycle but this does not guarantee movement through the cycle if profitable disposal as raw materials for new products is not available. While the gap between annual retirements and annual processing of scrap vehicles is closing through product upgrading made possible by improved processing equipment such as shredders, this does little more than decelerate annual additions to the accumulated inventory. Estimates of cars retired versus cars processed appear below (Figure IV-8).



*Includes No. 2 bundle production exports and shredded hulks

FIGURE IV-8. CARS RETIRED AND CARD PROCESSED, in millions, 1955-1969
Source: Scrap Age, 28(2):182, Feb. 1971.

The accumulated inventory of retired vehicles available for recycling is subject to a wide variety of estimates, ranging from 12 to over 20 million units. The most frequently quoted number is 20 million units. Little current quantitative data exists on the actual number, type and their locations.* A study for the Environmental Protection Agency is now being conducted to develop such data. The problem should then be able to be more realistically attacked, particularly on a regional basis. Nevertheless, the number is significant. The following chart indicates the estimated accumulation.

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*Two excellent studies on this problem are: U.S. Bureau of Mines. Automobile disposal; a national problem. [Washington], U.S. Department of the Interior, [1967]. 569 p. G. F. Derrickson. (Business and Defense Services Administration.) Motor vehicle abandonment in U.S. urban areas, nature and extent of problem, and adequacy of present methods of handling it. Washington, U.S. Government Printing Office, Mar. 1967. 51 p. Both are unfortunately based on 1965 information, and processing/use conditions have changed significantly since that time.

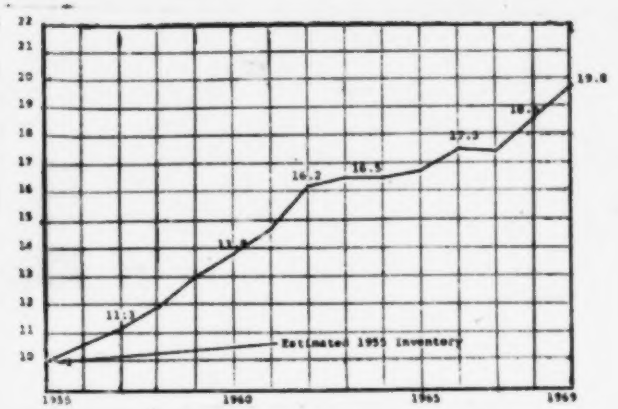


FIGURE IV-9. JUNKED CAR ACCUMULATION (million cars)
Source: Scrap Age, 28(2):182, Feb. 1971.

Of these 20 million, it is estimated that nearly 16 million are already in some stage of the scrap cycle, i.e., auto wrecking/dismantling yards or scrap processors. This number will eventually be recycled, and become raw materials for new iron and steel products when the demand exists. The remaining 4 million have been abandoned, and present a real solid waste management problem. The estimated distribution of the inventory is shown below.

ACCUMULATION OF 20 MILLION VEHICLES

	Million Vehicles	Urban	Rural	Total
Auto Wrecking Yards	14.5	28.0%	45.0%	73.0%
Graveyards	.6	.7	2.3	3.0
Scrap Processors	1.2	3.5	2.5	6.0
Abandoned	3.6	6.0	12.0	18.0
		38.2%	61.8%	100.0%

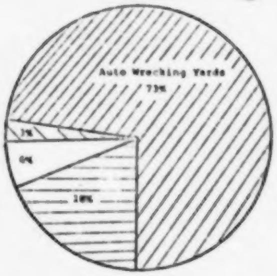


FIGURE IV-10. JUNK CAR DISTRIBUTION

Source: Scrap Age, 28(2):182, eb. 1971.

These are five major reasons which explain why these abandoned car vehicles are not entering the scrap cycle:

(1) Cost. Processing costs of a complete car in a scrap yard have been estimated at $51 per vehicle to produce $56 of marketable ferrous and nonferrous products.(1) The processing considered was receiving, incineration, dismantling, separation, and preparation. If the car has been stripped of easily removed and valuable parts such as its radiator, battery, or engine, this thin profit margin disappears. In the case of many abandoned vehicles, this stripping has been done.

It should be noted that the study cited considered a somewhat hypothetical situation. In most cases, the car received at a scrap processing yard has been stripped of many valuable parts by either an auto wrecker or scavengers of abandoned vehicles. Therefore, some of the processing indicated may not be done at the scrap yard. Nevertheless, the situation studied serves to illustrate the relatively low profit potential.

(2) Transportation. The cost of removing the abandoned vehicle and transporting it to a wrecker/dismantler or scrap yard for processing, such as above, further erodes any profit margin. Abandonment in rural areas accentuates this problem. It is estimated that almost twice as many abandoned vehicles are located in rural areas as in urban areas.(2)

(3) Legal Obstacles to Removal. Antiquated titling laws, holding (impounding) periods, double and triple tows, and nonuniformity of laws hinder the efficient and profitable removal of abandoned vehicles.

(4) Lack of Demand for the Processed Scrap. If scrap consumers are not buying, the scrap processor does not buy from auto wreckers, and the

auto wrecker does not buy any except late model vehicles which will bring him a profit from sale of parts. Therefore, obsolete vehicles pile up; it has been estimated that over 5 million vehicles in auto wreckyards have little or no parts value.(3) This demand obstacle will be covered in detail later, as will transportation and legislation.

(5) Quality of Processed Scrap. An obsolete motor vehicle, like many other consumer durable items, is a complex composition of numerous materials, as can be seen in Table IV-13.

TABLE IV-13. COMPOSITION OF TYPICAL AUTOMOBILE

Material	Pounds	Total automobile, percent	Total metal, percent
Light steel	1,309.5	36.6	40.9
Heavy steel	1,222.4	34.2	38.2
No. 2 bundle steel	2,531.9	70.8	79.1
Cast iron	511.4	14.3	16.0
Copper[1]	31.9	.9	1.0
Zinc[2]	54.2	1.5	1.7
Aluminum[3]	50.6	1.4	1.6
Lead	20.4	.6	.6
Rubber	145.0	4.1	-
Glass	87.2	2.4	-
Other combustibles[4]	127.2	3.6	-
Other noncombustibles[5]	14.8	.4	-
Total	3,574.6	100.0	100.0
Total metals	3,200.4	-	-

[1] Including copper in brass but not copper in solid solution in steel.
[2] As zinc base die cast exclusively.
[3] As scrap sheet and cast aluminum.
[4] Cardboard, textiles, padding, plastics, petroleum products, etc.
[5] Dirt, glass wool insulation, body putty, and ceramics.

Source: Dean, K. C., and J. W. Steiner. Dismantling a typical junk automobile to produce quality scrap. U.S. Bureau of Mines Report of Investigations 7350. Washington, U.S. Department of the Interior, 1969. p.7.

The location of the metals makes their separation extremely difficult although separation is a requirement to obtain full value. The parts where the metals are used are shown in Table IV-14.

TABLE IV-14. METAL CONTENT OF TYPICAL AUTOMOBILE PARTS

Part	Weight, pounds	Weight of metal in part, pounds					
		Cu	Al	Zn	Cast Fe	Light Fe	Heavy Fe
Battery, cable, and clamps[1]..........	36.5	0.8	-	-	-	-	-
Radiator..............	14.5	13.0	-	-	-	1.5	-
Engine................	454.5	-	12.5	-	374.00	12.0	56.0
Differential[2].........	153.5	.2	-	-	51.2	17.3	84.7
Flywheel housing......	9.4	-	8.7	-	-	-	.7
Starter and solenoid..	15.5	2.8	1.0	-	-	.2	11.5
Generator.............	12.0	2.6	1.5	-	-	2.9	4.9
Coil..................	2.0	.5	-	-	-	1.1	-
Voltage regulator.....	1.1	.2	-	-	-	.9	-
Thermostat[2]	.7	.5	-	-	-	-	-
Fuel pump[2]...........	3.5	.2	.8	2.0	-	.5	-
Carburetor[2]...........	6.5	.2	1.1	3.8	1.5	.4	-
Distributor...........	4.0	-	.3	.3	2.7	.3	.5
Engine wiring.........	.5	.4	-	-	-	-	-
Electric motors.......	8.9	.8	1.5	1.8	-	2.6	2.1
Heater core...........	8.2	2.4	-	-	-	-	-
Dashboard wiring......	2.3	.8	-	-	-	.3	-
Instruments[2]..........	3.9	.5	-	1.8	-	.8	-
Radio.................	4.6	.3	-	2.0	-	1.8	-
Interior trim.........	21.1	-	1.5	16.2	-	3.4	-
Body wiring...........	7.2	4.0	-	-	-	.6	-
Mirrors, light covers.	12.0	-	-	1.8	-	.3	-
Interior handles......	3.6	-	-	3.4	-	.2	-
Exterior handles......	4.2	-	-	4.2	-	-	-
Horn and relay........	3.3	.2	-	2.1	-	1.1	-
Tubing................	2.1	.4	-	-	-	1.7	-
Exterior trim, grill..	15.5	-	6.4	8.1	-	.8	.2
Window frames.........	11.4	-	-	6.7	-	4.7	-
Transmission[2] [3].......	153.8	.2	15.3	-	3.6	19.5	115.1
Brake drums and cylinders[2] [3].........	79.4	.2	-	-	73.2	2.3	3.6
Bumpers and trim (Ni-Cr steel)........	79.5	-	-	-	-	79.5	-
Body trim and decoration...........	4.8	-	-	-	-	4.8	-
Steering gear box[3]....	8.0	-	-	-	5.2	1.3	1.5
Wheel cover and wheels	78.7	-	-	-	-	9.9	68.8
Heavy iron (springs, suspensions, hubs, gears, palls, oil pump, frame).........	874.3	-	-	-	-	-	874.3
Light iron (body and light spring steel)..	1,136.8	-	-	-	-	1,136.8	-
Total...........	3,179.3	31.2	50.6	54.2	511.4	1,309.5	1,222.4

[1] The lead content of the battery and battery cable clamps is 20.4 pounds.

[2] These parts contain copper as yellow brass in the following pound quantities: transmission 0.3, differential 0.3, thermostat 0.7, fuel pump 0.2, carburetor 0.2, instruments 0.7, brake drums and cylinders 0.3.

[3] The cast iron in these parts cannot be readily separated from the steel components.

Source: Dean, and Steiner, Dismantling a typical junk automobile, 1969. p.6.

The ferrous content may be prepared as scrap in a number of ways. Prior to scrap processing, parts having resale value are removed, as are nonresalable but valuable nonferrous scrap components, such as the radiator. Then, the remaining hulk may be prepared for shipment as scrap in any of the following ways, or in combination: removal of the engine for sale as cast iron scrap, a premium grade; removal by torch cutting of the frame, springs, wheels, or other parts at least 1/8" thick for sale as No. 2 heavy melting scrap; baling of the remaining vehicle for sale as No. 2 bundles; shredding of the hulk for sale as shredded or fragmentized scrap; or compressing and shearing into automotive slabs. The predominant processing method is preparation as No. 2 bundles, although processing by shredding is increasing.

No. 2 bundles have limited acceptability by iron and steelmakers due to their high level of impurities, in the form of nonferrous metals and dirt. The most serious contaminant is copper, whose presence affects the drawing quality and surface of the finished steel. Unlike aluminum and zinc impurities which generally oxidize during the steelmaking process, copper, tin, and nickel impurities are carried through to the finished steel as an unwanted residual. At times, the use of No. 2 bundles is desirable, due to their low price relative to higher quality grades if the finished steel product can stand the contaminant level, or for use as a small part of a charge where the effect of the contaminants is diluted, or in products such as low alloy steels where the residual are desirable.

The copper contaminant level that is acceptable is subject to widespread opinion, but in general, the desirable content in finished steels is:

Low quality steels	0.5 percent copper
Average quality	0.3 percent copper
High quality	0.1 percent copper
Deep drawing quality	0.05 percent copper

By comparison, the copper content of typical No. 2 bundles averages 0.48 to 0.58 percent copper. Residual levels of a variety of scrap types are shown below (Table IV-15).

TABLE IV-15. SCRAP IMPURITY CONTENTS

	Cu	Sn	Ni	Mo	S	Cr[1]
No. 1 Factory Bundles	0.06	0.005	0.04	0.03	0.025	0.04
No. 1 Industrial H.M.	0.10	0.010	0.05	0.03	0.035	0.04
No. 1 Railroad H.M.	0.16	0.010	0.15	0.03	0.040	0.05
No. 1 Dealer Bundles	0.12	0.016	0.06	0.03	0.040	0.05
Car Sides, Bundles	0.27	0.018	0.06	0.03	0.055	0.04
No. 2 Dealer H.M.	0.40	0.027	0.20	0.03	0.080	0.10
No. 2 Dealer Bundles	0.48	0.060	0.09	0.03	0.100	0.06
Shredded Scrap	0.22	0.025	0.10	0.02	0.030	0.16

[1] These values may be used to estimate chromium in the final heat, if it is assumed that none is lost in the slag. Actual Cr contents are probably several times these amounts.

Source: (Shredded). Industry sources; (All others). Custer, C. C. The quality aspects of a cold metal practice vs. a hot metal practice. Presented at the 47th National Open Hearth and Basic Oxygen Steel Conference, American Institute of Mining, Metallurgical, and Petroleum Engineers, Apr. 13, 1964.

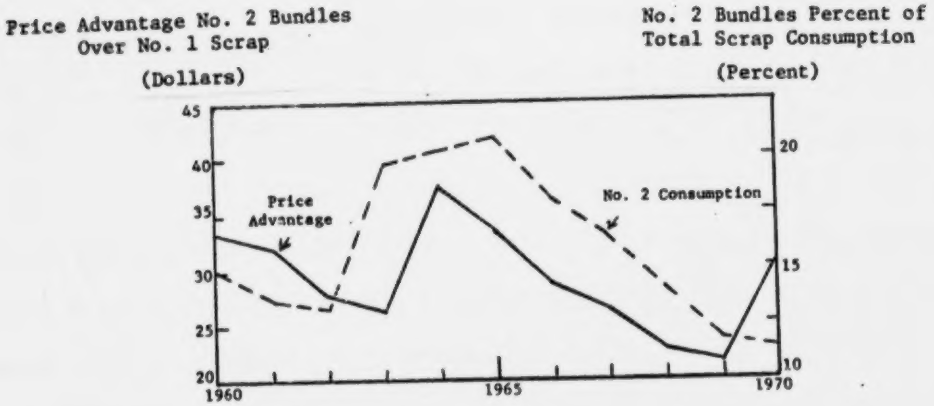
As can been seen, the No. 1 types provide a quality scrap product, whereas the No. 2 types, due to their obsolete heterogeneous scrap sources are higher in residual levels, and as a result, less desirable from an iron and steelmaking quality standpoint.

It was primarily because of the contaminant levels of No. 2 bundles that shredding systems, already in use primarily for turnings and can scrap shredding for copper precipitation, were developed for processing of obsolete scrap. In the system, detailed later in this report, the shredded product contains less than half the copper content of No. 2 bundles, averaging 0.15 - 0.25 percent copper. This product is rapidly gaining acceptance; in 1970, over 2 million tons of shredded scrap were shipped to the domestic and export scrap markets. There are also other methods which can further lower the copper content in obsolete vehicle scrap, such as the ripper-shredder system,(4) or hand dismantling.(1)

However, at current scrap demand levels and with an adequate supply of higher quality scrap, there is little economic incentive to seek lower copper levels. In recent years, the average price of No. 2 bundles has generally been in excess of 70 percent of the price of No. 1 heavy melting scrap. At these levels, there is little incentive for the consuming industries to seek increased utilization of No. 2 bundles on price alone. Usage of No. 2 bundles bears a good correlation with its price relative to that of higher grades.

As indicated in Figure IV-11, the proportion of No. 2 bundles consumed relative to total scrap consumption generally has varied directly with the amount of price advantage to the consumer. Other than at times of short scrap supply, there is little reason for the iron and steel industries to consume larger amounts of No. 2 bundles with their lower iron content and quality if significant price advantages to compensate for potential risk are lacking.

FIGURE IV-11. CONSUMPTION OF NO. 2 BUNDLES RELATIVE TO PRICE ADVANTAGE, 1960-1970.



Source: Battelle-Columbus Laboratories.

It is recognized that other factors besides price affect No. 2 bundle usage. However, price advantage is a strong determinant.

The implications for ferrous solid waste management are clear--unless obsolete scrap can be supplied to processors at a cost enabling both profitable processing and usage by consumer and unless the demand for ferrous scrap of all types increases at a greater rate than scrap accumulation, it will accumulate as ferrous solid waste.

The Steel Can

Second only to the junked automobile in terms of environmental attack on ferrous solid waste is the steel can. Steel containers, while less than 2 percent of the total municipal and industrial solid waste generated annually in the United States, are nevertheless a highly visible portion of that waste, and therefore an obvious target for ecological action.* Economic dislocations are threatened within supplying industries through "Ban the Can" movements. Discarded containers are, however, a large potential source of raw material for recycling.

In 1970, over 6 million tons of steel tin mill product, i.e., black plate, tin plate, and tin-free steel, were shipped to the Containers, Packaging and Shipping Materials market, almost 7 percent of total steel product shipments. Approximately 85 percent went into the manufacture of steel cans, with the remainder used in strapping, shipping barrels, drums, and pails, and miscellaneous applications.

Total metal can production in 1970 was about 76 billion units. By contrast, glass container shipments were 38 billion. Food cans represented 47 percent; beverage cans 39 percent (beer - 23 percent, soft drinks - 16 percent); and other uses accounted for the remaining 14 percent. Steel represents about 90 percent of the total can raw material, with aluminum taking the bulk of the remainder.(5)

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* The composition of municipal solid waste and its ferrous components are shown in Table IV-19 and IV-20. On a total dry weight basis, ferrous materials approximate 7.5 percent of raw refuse; cans represent less than 20 percent of incinerator residue. Little regional differences occur.

Two basic coated steel products are used in can manufacture. Tin-plated steel, in standard and thin-tin gauges, predominates with over 80 percent of the total steel consumed. The tin primarily serves one purpose - to act as a base for seam soldering; the actual interior protection is provided by special resin coatings applied by the can manufacturer. In response to tin price and supply fluctuations, tin-free steel was recently developed, and is making inroads on traditional tin-plate markets, primarily in beverage containers. This product utilizes a metallic chromium-chromium oxide film combination. As more becomes available from steel suppliers, and with the continuing development of improved side seaming techniques by can manufacturers, it should continue its growth.

Many of the steel cans used for beverage containers use aluminum tops because of aluminum's easy open characteristics. However, recently developed steels, with these characteristics such as good scoring properties, should permit the return to the all-steel beverage container as the supply becomes available.

Metal cans are an American way of life.* While packaging of food, beverages, and other products is possible by other means, the simple can has provided an economic, convenient, safe, and sanitary method of packaging goods. It is a billion dollar industry, yet the cost per can is measured in cents. Per capita consumption approaches one per day; or an average consumption of over 1,000 per family annually.(6)

The can is today under attack from many sides. "Ban the Can" legislation has already been enacted in a number of areas, and it is expected that restrictive legislation will be seen in 49 of the 50 states by the end of 1971;(7) another source noted that more than 200 bills are before 45 legislatures on nonreturnable bottles alone.(8) Most of the effort has dealt with the

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* Because of the difficulty in obtaining accurate statistics, metal cans will be used synonomously with steel cans, which represent over 90 percent of all metal cans. A distinction will be made when possible or important.

one-way beer and soft drink container. This segment of the total beverage container market has been increasing rapidly. Beer has been the leader--in 1960, slightly over 50 percent of all packaged sales were made in returnable bottles; by 1970, this had shrunk to about 25 percent. Nonreturnable bottles account for 22 percent and metal cans for 53 percent. In soft drinks, about 90 percent of all sales were made in returnables in 1960; in 1970, the returnable share had shrunk to 45 percent. Nonreturnable bottles accounted for 24 percent and metal cans for 31 percent. Steel represents over 85 percent of the total 32 billion beverage cans produced in 1970, with aluminum taking the bulk of the remainder.(5)

These cans are charged with contributing an unbearable burden to our solid waste problems, and an affront to our aesthetic senses through their litter. A brief examination of these charges is in order to put them in perspective.

The range of all ferrous products in municipal solid waste is between 6 and 10 percent of the total. These national averages show little variation by region. After elimination of the combustibles through incineration, cans average between 15 to 20 percent of the residue. It is therefore apparent that elimination of cans would not make a major dent in our total solid waste problems. Tables IV-16 and IV-17 detail municipal solid waste composition.

TABLE IV-16. MUNICIPAL SOLID WASTES PHYSICAL CHARACTERISTICS DATA

A. NATIONAL

Expected Ranges in Mixed Municipal Refuse Composition

	Percentage Composition as Received (dry weight basis)			
Component	**Anticipated Range**		**Nominal**	
Paper		37-60		55
Newsprint	7-15		12	
Cardboard	4-18		11	
Other	26-37		32	
Food		12-18		14
Metallics		7-10		9
Ferrous	6-8		7.5	
Nonferrous	1-2		1.5	
Glass		6-12		9
Yard		4-10		5
Wood		1-4		4
Plastic		1-3		1
Miscellaneous		<5		3
				100

Note: Moisture content range 20-40 percent, nominal 30

Range in Composition of Residential Solid Wastes in 21 U.S. Cities

	Percentage Composition by Net Weight	
Component	**Range**	**Average**
Paper products	13.0-62.0	43.8
Food waste	0.8-36.0	18.2
Metals	6.6-14.5	9.1
Glass and ceramics	3.7-23.2	9.0
Garden waste	0.3-33.3	7.9
Rock, dirt, ash	0.2-12.5	3.7
Plastics, rubber, and leather	1.6-5.8	3.0
Textiles	1.4-7.8	2.7
Wood	0.4-7.5	2.5

B. REGIONAL

Geographic Differences in Major Categories

Location	Paper	Metal	Glass	Food	Wood	Plastics, Leather, Rubber, Cloth, Synthetics
New Jersey	51	8	4	10	4	4
Illinois	42	9	6	14	-	-
Ohio	42	9	8	28	3	3
Arizona	43	10	8	22	2	1
California	54	7	2	15	2	2
Kentucky	-	9	6	11	-	-
New York	40	8	-	10	7	3
Tennessee	46	11	11	26	<1	5

Sources: Testin, R. F., and N. L. Drobny. Processing and recovery of municipal solid waste. Journal of the Sanitary Engineering Division, Proceedings of ASCE, 96(SA3):699-714, June 1970. Hickman, H. L., Jr. Characteristics of municipal solid wastes. Scrap Age, 26(2):305-307, Feb. 1969.

TABLE IV-17. COMPOSITION OF INCINERATOR RESIDUES

Component	Percent Composition, Dry Weight Basis
Atlanta, Georgia: Rotary Kiln Incinerator	
Ash, slag, and glass (minus 8-mesh)	35.8
Glass and slag (plus 8-mesh)	21.2
Shredded tin cans	19.3
Mill scale and small iron	10.7
Nonmetallics from shredded cans	6.5
Charcoal	3.7
Massive iron	1.9
Iron wire	0.5
Ceramics	0.1
Hand-picked nonferrous metals	0.1
Washington, D.C.: Grate-Type Incinerators	
Glass	44.0
Tin cans	17.2
Ash	15.4
Unburned paper and charcoal	8.3
Mill scale and small iron	6.8
Massive iron	3.5
Nonferrous metals	1.4
Stones and bricks	1.3
Ceramics	0.9
Iron wire	0.7
Partially burned organics	0.7

Source: Kenahan, C. B., P. M. Sullivan, J. A. Ruppert, and E. F. Spano. Composition and characteristics of municipal incinerator residues. U.S. Bureau of Mines Report of Investigations No. 7204. [Washington], U.S. Department of the Interior, Dec. 1968. p.8-9.

On the litter problem, a recent 29-state study indicated that cans made up only 16.3 percent of all roadside litter. Further, it has been estimated that only 1 percent of all nonreturnable cans wind up as litter.(7)

It is argued therefore that the economic dislocations of major industries which would take place through a total "Ban the Can" legislation are not justified by the relatively minor solid waste benefits to be achieved. One estimate places the cost at $4 billion, including the loss of jobs, obsolescence of equipment, and the incalculable losses to the owners, i.e., stockholders of the affected industries.(7)

When surveyed, people say they would return containers.(9) However, the evidence is to the contrary. Consumers have been buying less and less beverages in returnables. Despite ecology advertising programs and/or increased deposits on bottled, the convenience of the garbage can wins out. In New York City, the average returnable bottle makes only two round trips before it is thrown away and becomes solid waste. The national average is less than 20.(6) Coca-Cola stated its bottles make less than 10 trips, with at least double that number required to make it worthwhile.(10)

In Baltimore, deposits were more than doubled and an economy and ecology advertising program was launched earlier this year. But the program had the opposite effect, as sales on nonreturnables increased.(11) Therefore, it is questionable as to the degree of any positive environmental improvement that a ban on nonreturnable beverage containers would have.

In addition, a higher average cost per container to the consumer would undoubtedly be involved. As a result of consumer preference for the nonreturnables and trends toward increased metal can preference at the expense of glass, regional packaging and distribution centers have evolved instead of the higher cost local bottling facilities. Because of transportation and other costs, a return to the local packaging would seem indicated, thereby raising the total average cost of packaging and distribution. Extra storage space in stores would be required. Finally, the high cost of sorting, hauling, washing, and refilling would end up being paid for by the consumer. Estimates on the total additional cost to the consumer per beverage have not been developed, and therefore it is difficult to judge the effect of such a transition. However, it would appear that the cost might well exceed voluntary consumer acceptance.

But--this is not to say that the solid waste aspects of the metal can should be ignored. Present practices regarding the disposal of metal cans without question contribute to our solid waste and litter problems, even though the contribution may be small. In addition, it is a waste of a potentially valuable source of raw materials for new ferrous products or other uses. Recycling provides the answer to both problems.

Three basic uses are available for used steel cans. Two of the uses, copper precipitation and detinning, are covered in some detail in Chapter V of this report. But the major potential use is as a portion of the scrap charge to iron and steelmaking furnaces.

Two basic deterrents to their use, however, exist. They are

(1) Scrap quality

(2) Can logistics economics.

Steel cans contain "tramp" elements which are generally undesirable in steel or foundry products. For example, beverage cans contain up to 2 percent lead, 0.5 percent tin, and up to 10 percent aluminum (from can lids) residuals. Incineration lowers these contents in salvaged cans, but results in a pickup of up to 0.7 percent of copper which fuses to the can scrap. The composition of steel cans and incinerated scrap are shown below (Tables IV-18 and IV-19).

TABLE IV-18. COMPONENTS OF TYPICAL STEEL CANS USED FOR BEER OR BEVERAGE (pounds/ton)

	Tin-Plated Steel		Tin-Free Steel Beer Can
	Aluminum End	Tin Steel End	Aluminum End
Organic Coatings	36.6	36.6	36.60
Aluminum	204.0	0	204.00
Lead	36.8	36.8	- -
Tin	8.4	9.6	- -
Chromium	- -	- -	0.12
Steel	1,714.2	1,917.0	1,759.28

Source: Ostrowski, E. J. Recycling tin-free steel cans. Presented at 79th General Meeting, American Iron and Steel Institute, May 26, 1971.

Source: Ostrowski, Recycling tin-free steel cans, 1971.

TABLE IV-19. CHEMICAL COMPOSITION OF INCINERATED SCRAP INCLUDING 95 PERCENT CONFIDENCE BAND (percent)

	Average	Limits	
		Lower	Upper
C	.020	.008	.032
S	.032	.028	.037
Mn	.013	.005	.021
P	.034	.005	.062
Sn	.165	.147	.182
Cu	.437	.252	.621
Cr	.009	.001	.0187
Ni	.100	.065	.134
Mo	.015	.009	.021
Pb	.104	.086	.122

Source: Ibid.

Small amounts of lead vaporize during steelmaking but large amounts cause severe damage to the furnace refractories. Over about 0.01 percent of lead in cast iron adversely affects the morphology of graphite flakes. Less than 0.1 percent tin strengthens cast iron, but even low amounts are undesirable in steel. Copper improves the resistance of steel to atmospheric corrosion and also imparts strength, but the content must not exceed the solid solubility limit of about 0.2 percent to avoid hot shortness during rolling. Hot shortness in steel is also aggravated by the presence of tin. Aluminum may create blow holes in cast iron.

Of these four tramp elements, the tin and copper in the charge will be carried over into the end product from melting a charge of can scrap. It has not been fully established to what extent tramp elements are carried over by modern melting practices in producing iron or steel from municipal ferrous scrap. However, certain guidelines have been established (Table IV-20).

TABLE IV-20. RECOVERY OF RESIDUAL ELEMENTS COMMONLY FOUND IN REFINED STEEL

Element	Recovery in final product, per cent of total weight charged to steelmaking system
Phosphorus	1-20*
Sulphur	1-5**
Manganese	5-25
Chromium	25-75
Tin	90-100
Arsenic	90-100
Molybdenum	90-100
Copper	95-100
Nickel	95-100
Cobalt	95-100

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* In acid steelmaking processes, phosphorus recovery is 90-100 per cent.
** Does not include sulphur in gaseous or liquid refining fuels.

Source: Jacobs, Elliott and Tenebaum, "Significance of Minor Elements in Iron Bearing Raw Materials for Integrated Steel Plants," AISI General Meeting, May 27, 1954.

National Steel reported recently that in its basic oxygen furnace tests, all tin was recovered in the ingot; the lead was recovered as an oxide in the effluent dust generated in the process. No lead accumulation in the furnace was noted and sulphur and phosphorous control presented no problems.(12)

In addition, residual buildup over time is an important consideration. Calculated buildup in ingots using hot metal produced from incinerator scrap is shown in Figure IV-12. Buildup from incinerated scrap usage as a charge material in a basic oxygen furnace is shown in Figure IV-13.

FIGURE IV-12. **Upper limit of copper, tin and nickel residual buildup in ingots using hot metal produced with varying amounts of incinerated scrap.**

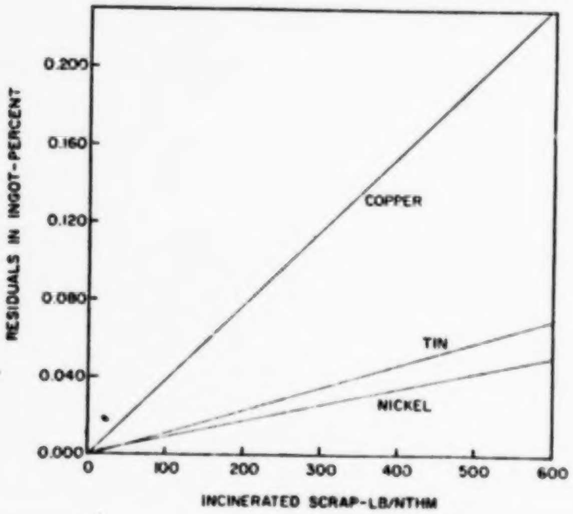
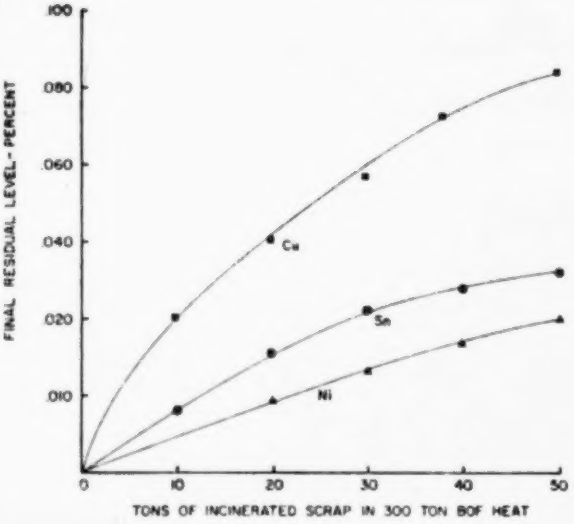


FIGURE IV-13. Residuals in final product of 300-ton heat using incinerated scrap.



Source: Ostrowski, Recycling tin-free steel cans, 1971.

It has not been fully established to what degree the carryover affects the physical and mechanical properties of iron and steel. Therefore, it is necessary to further investigate melting practices for producing iron and steel from salvaged municipal scrap to learn which practices result in the lowest carryover of the tramp elements. It is also necessary to investigate the properties of the resulting iron and steel to determine whether they reduce the acceptability for potential end uses. Finally, the most acceptable melting processes must be evaluated with respect to capital costs and operating costs.

Some research is already being conducted in these areas. The steel industry in March of 1970 committed itself to the use of controlled amounts of steel cans as part of its scrap charge. An American Iron and Steel Institute Task Force on Solid Wastes was established, and in conjunction with the Institute of Scrap Iron and Steel, arranges for collection, processing, and scrap usage in response to requests. Previous R&D efforts culminated on June 8, 1970, in a pilot demonstration at the Weirton Steel Company, Division of National Steel Corporation. Five hundred thousand tin-free cans, compacted into bundles making up 25 tons of a 55 ton scrap charge were successfully used in a 40-minute 355 ton heat of BOF steel, subsequently degassed, slab cast, and finished into sheet steel. The demonstration indicated the technical feasibility of using can scrap. Additional work is being conducted in the electric furnace and blast furnace. An excellent discussion of this work is described in the National Steel presentation cited above.(12)

However, it must be noted that to date, most of the work has involved tin-free cans. Only controlled amounts can be used at present due to the aluminum "easy-open" tops; aluminum may cause detrimental reactions in steelmaking processes, altering the slag chemistry and leading to vessel slopping in the basic oxygen process. Recent development of the "easy-open" steel top should alleviate this situation in the future.

The ability to use conventional tin-plate as a scrap charge, as previously noted, is hampered by its lead and tin content. While a certain amount of lead is oxidized during the BOF melting (it is not if used in the blast furnace, a reducing atmosphere), a still troublesome amount remains, causing steel quality and refractory problems. In addition, tin may cause quality problems, and careful control must be exercised to keep these residuals at a low level. Chemical removal of the tin and lead is technically possible, but is uneconomic. Furthermore, crimping of the can during fabrication makes total removal of tin impractical. Again, this situation should be alleviated in the future with increased consumption of tin-free steel.

Significant work is also being done at the University of Wisconsin. Under sponsorship of the Bureau of Mines, ferrous scrap from municipal waste, of which cans are the major component, is being further evaluated as to its composition, characteristics, and proper balance as a foundry charge material.

Therefore, increased consumption of steel cans as a scrap charge material by the iron and steel industries, from a quality standpoint alone, depends on:

(1) Further definition of the scrap characteristics and specifications of steel can scrap

(2) Development of economic melting practices to produce the desired quality iron and steel from scrap containing steel cans

(3) Development of competitive refractory materials to withstand tin and lead attack, an attack heretofore not encountered.

Progress is being made in these areas, but needs acceleration if the achievement of wide-spread can recycling is to become a reality.

However, it is with the second deterrent, logistics, that the real problem exists. Stated in simple terms, how does the can get from the final consumer to the iron or steelmaking facility economically? Segregation and collection are the two major problem areas. Where should the segregation be done--at the housewife level, where she separates cans from all other garbage; or steel cans from other cans, or tin-free cans from tin-plated cans, or after municipal collection and separation. Undoubtedly separation of cans from all other garbage would be enough, as magnetic separation of steel cans from all others at a collection center is simple and inexpensive although the chemical composition of each type varies, i.e., tin-free, tin-plated, or incinerated scrap, with varying effects on steelmaking. But would average Mrs. America voluntarily do it? Is she concerned enough about her environment to comply even if legislated? What penalties are feasible for noncompliance? This approach has a series of notable failures, Los Angeles to mention just one; perhaps the mood of America is now right for another try. But is it the most efficient, feasible, or inexpensive way?

Much favorable publicity and attention has been given to reclamation centers, now operating in 16 or more states. Promoted primarily by the major aluminum , steel, and can companies, these centers accept cans from individuals and community groups for recycling. The cans have their labels removed, are rinsed, and then flattened. At the steel and can centers, any profit accruing from sale will be given to local environmental projects. At the aluminum centers, payments are $10 per ton for bi-metal cans (steel and aluminum), $20 per ton for all steel cans, and $200 per ton for all aluminum cans. This approximates 1/2 cent per aluminum can and 1/10 cent per steel can. In 1970, about 115 million aluminum cans were brought to reclamation centers, providing payments of $575,000 to individuals and community groups. This is certainly a start in the right direction, but because it takes 40,000 aluminum cans to make a ton, (about 20,000 if steel cans) less than 3,000 tons of aluminum was collected in this fashion of the total 200,000 plus tons of aluminum consumed in all aluminum cans. The pace has greatly accelerated so far in 1971, but it is doubtful that this method will signficantly affect the total potential recyclable metal in the near future, particularly as steel cans are 90 percent of the total and have relatively low value payments.

The approach most commonly suggested is separation from the municipal solid waste with or without incineration. Numerous programs are under study in this area. Prominent among these are the Bureau of Mines work at College Park concerned with the separation, recovery, and effective utilization of metallic and mineral values of residues from municipal incinerators; the Black Clawson processing unit in Franklin, Ohio; systems in Chicago, Atlanta, Houston, and San Francisco; and numerous demonstration projects being conducted through the Solid Waste Management Office. The full answer is complex; variations exist from location to location as do the needs.

The best answer seems to lie in a total system, one in which all solid waste is fed in one end of a "black box" and out the other end comes materials, properly segregated and prepared for economic commercial use. The Bureau of Mines has demonstrated the technical feasibility of processing incinerator residues on a continuous basis to reclaim the contained metal and mineral values.(13) Work is now being conducted on the separation of such values from raw refuse, i.e., nonincinerated. Their system, as part of a total system, such as proposed by the Aluminum Association,(14) appears to offer significant potential. But like all else in the recycling field, once values have been obtained from the exit end of the "black box", a market must exist for these products if effective utilization is to be carried out. And the existence of such a market is dependent to a great extent on the total economics of the separated products, their preparation for subsequent reuse, and their transportation to that market--at a competitive price. And therein lies the problem.

Therefore, the area needing the greatest additional study at this time concerns the logistics and economics of collection, preparation, and delivery of cans and other ferrous solid waste from municipal waste to markets. It has been indicated that the iron and steel industries would use such scrap, if its quality and price were competitive. At the present time however, except for isolated situations, neither quality or price make this material suitable for quantity recycling.

It is further recommended that research be conducted on potential other uses for can scrap. For example, an approach considering the intrinsic characteristics of can scrap, i.e., a thin-gauge, deformed, low density, small in size, ferrous material, as a starting point and then matching these properties to any current or future requirements for such a material might realize some significant outlets. Possibilities might include concrete reinforcement, insulation, aggregate, refractory materials - the possibilities are unlimited. Other possibilities may lie in new or improved iron or steel products taking advantage of the tin content, as opposed to current thinking which focuses on tin elimination. Tin additions are currently used in certain castings and alloy steels;(15) with controlled amounts of can scrap as part of the furnace charge, perhaps the tin can be obtained in a much less expensive manner. Another possibility might be with the use of can scrap as a partial raw material for iron powders, utilizing the tin as an aid for the sintering operation.(16) Another potential use for cans may be as a source for conversion to magnetite, Fe_3O_4, for use by coal producers for heavy media separation, and by iron powder producers.

An approach to litter is being undertaken by the Federal Highway Administration of the U.S. Department of Transportation.(17) Investigation is underway of both the technical and economic feasibility of using various components of litter deposited along the highway right-of-way as a material for highway construction, maintenance, or operation. Its purpose is primarily to make the highway system self-sufficient in terms of waste disposal rather than adding this burden to the already heavy waste disposal load carried by the local jurisdictions.

In summary, while steel cans are a contributor to this nation's litter and total solid waste problems, the economic cost of "Ban the Can" legislation significantly outweighs the social benefit or alleviation of solid waste problems that could be realized. However, current disposal practices represent not only a cost, but also a waste of potentially valuable raw material resource.

Recycling offers the greatest opportunity for recovery and utilization of that resource; in addition, it would help alleviate our solid waste problems. With proper preparation, quality, and competitive pricing, steel cans would be a marketable scrap product. Their recovery from a total system of solid waste disposal offers more long-range potential than short-range solutions to the problems, although reclamation centers are providing assistance in the short range. Therefore, the basic areas for further research are with the logistics and economics of can scrap.

Discarded Major Household Appliances

There are an estimated 350 million major appliances currently in use in the United States. They are being discarded at an annual rate of 2 million units which is expected to rise to 29 million units in 1980.(18) Very few are currently being recycled because handling and transportation costs are high relative to the scrap value of the appliance. Final disposition is handled by most municipalities by burial in landfill; in other instances, the appliances end up in junk yards or as blights on our landscape. In either case, they represent loss of potentially valuable raw materials for recycling, and add, although in a minor way, to our mounting solid waste problems and costs. The estimates above are detailed in Tables IV-21 and IV-22 below.

TABLE IV-21. MAJOR APPLIANCE OBSOLESCENCE
(millions of units)

Appliance	In Use	Estimated Age at Discard (years)	1971 Sales	1971 Discards	1980 Discards
Room Air Conditioner	25	10	6.22	1.50	5.89
Dehumidifier	N.A.	20	.78	.06	.38
Disposers	14	10	2.16	.80	1.98
Ranges	>63	20	4.80	3.76	3.30
Freezer	18	20	1.26	1.05	1.05
Refrigerators	>63	20	5.46	4.08	3.48
Dishwashers	16	10	2.43	.62	2.12
Washers	58	8	4.54	3.99	4.50
Dryers	25	15	3.34	1.61	2.10
Water Heater	<63	10	4.50	3.52	4.46

Source: National Industrial Pollution Control Council. The disposal of major appliances; Sub-council report. Washington, U.S. Government Printing Office, June 1971. p.10-11.*

TABLE IV-22. YEARLY APPLIANCE DISCARDS, 1971-1980
(millions of units)

	Estimated Age at Discard (Years)	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Room A/C	10	1.50	1.58	1.95	2.78	2.96	3.35	4.13	4.03	5.46	5.89
Dehumidifiers	20	.06	.09	.09	.08	.10	.28	.23	.21	.35	.38
Disposers	10	.80	.89	1.09	1.30	1.36	1.41	1.36	1.81	1.94	1.98
Ranges	20	3.76	3.25	3.43	3.37	3.93	3.77	3.34	3.23	3.70	3.30
Freezers	20	1.05	1.14	1.09	1.00	1.10	.98	.93	1.10	1.21	1.05
Refrigerators	20	4.08	3.57	3.65	3.60	4.20	3.70	3.35	3.12	3.79	3.48
Dishwashers	10	.62	.72	.88	1.05	1.29	1.52	1.59	1.96	2.12	2.12
Washers	8	3.99	4.22	4.39	4.45	4.37	4.52	4.44	4.10	4.54	4.50
Dryers	15	1.61	1.27	1.20	1.38	1.24	1.18	1.40	1.59	1.83	2.10
Water Heaters	10	3.52	3.78	3.55	3.72	3.84	3.68	3.81	4.24	4.29	4.46
TOTAL		20.99	20.51	21.31	22.52	24.38	24.38	24.58	24.39	29.20	29.24

Source: Ibid.

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* The following quote from the NIPCC report, page 8 should be noted:

> "No firm data are available on the life of major appliances, nor the number that are discarded each year. However, the studies of the service life of durable goods by Pennock and Jaeger[1] begun in 1957, the studies of the life of steel-containing goods made by the Battelle Memorial Institute[2] in 1957, and an informal survey of appliance life made as a part of this investigation, provide information adequate for the purpose of this report."

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[1] Pennock, J. L., and C. M. Jaeger. The household service life of durable goods. Journal of Home Economics, Jan. 1964.

[2] Final report on a survey and analysis of the supply and availability of obsolete iron and steel scrap. Columbus, Battelle Memorial Institute, Jan. 15, 1957.

The potential ferrous resource loss amounts to slightly under 2 million tons/year at a 21 million unit discard rate, based upon an average appliance weight of 200 pounds, of which iron and steel represent 80 - 90 percent. A materials balance for selected appliances appears in Table IV-23.

TABLE IV-23. MATERIAL USAGE IN SELECTED APPLIANCES AND VALUE AFTER REMOVAL AND SEGREGATION AT TYPICAL SCRAP PRICES

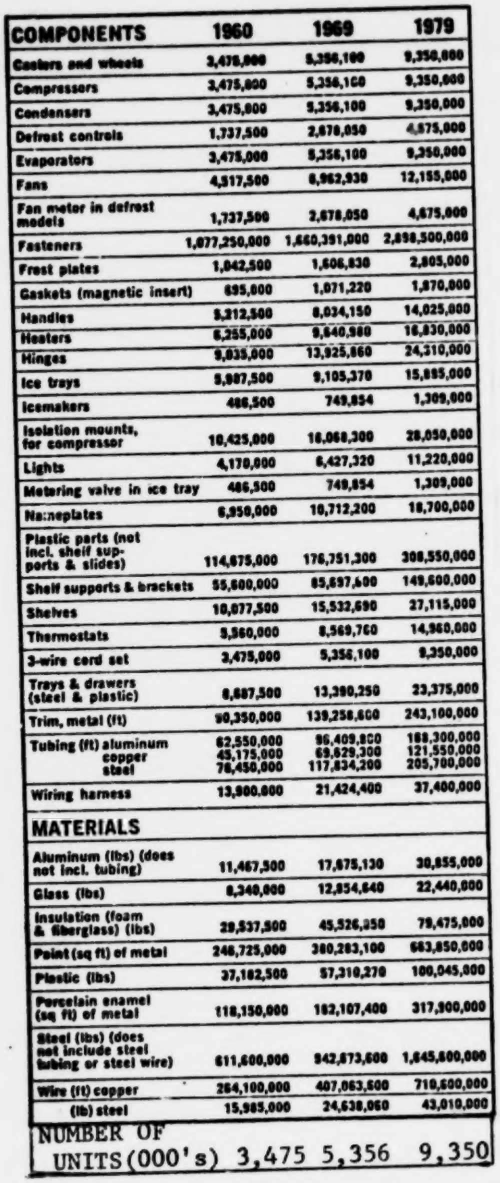
Weight and Scrap Value of Materials in Average Appliance
Based on
Steel—$.01/Lb. Copper and Brass—$.40/Lb. Aluminum—$.15/Lb.

Appliance Typical Low, Average and High Weight	Steel	Copper and Brass	Aluminum	Glass	Rubber and Plastic	Other	Total
Room Air Conditioners							
Low 59	62#	36#	10#	—	9#	8# Paper	125#
Avg. 125							
High 224	$ .62	$14.40	$1.50	—	—	—	$16.52
Ranges							
Low 150	178#	2#	2#	12#	2#	2# Zinc	200#
Avg. 200						2# Paper	
High 315	$1.78	$ .80	$ .30	—	—	—	$ 2.88
Refrigerators							
Low 290	260#	12#	9#	10#	34#	—	325#
Avg. 325							
High 375	$2.60	$ 4.80	$1.35	—	—	—	$ 8.75
Dishwashers							
Low 125	120#	5#	2#	—	20#	—	147#
Avg. 147							
High 175	$1.20	$ 2.00	$ .30	—	-	—	$ 3.50
Washers							
Low 220	207#	4#	15#	2#	7#	15# Concrete	250#
Avg. 250							
High 300	$2.07	$1.60	$2.25	—	—	—	$ 5.92
Dryers							
Low 135	132#	2#	4#	1#	6#		145#
Avg. 145							
High 155	$1.32	$ .80	$ .60	-	—	—	$ 2.72

Source: National Industrial Pollution Control Council, The disposal of major appliances, 1971, p.18-19.

The problem of recycling appliances is much the same as that involving motor vehicles. Both products contain a variety of materials, requiring substantial scrap processing to obtain adequate quality for iron and steelmaking. For example, the variety of components and materials used in manufacturing refrigerators is shown below (Table IV-24). But handling is a greater problem as approximately

TABLE IV-24. COMPONENTS AND MATERIALS USED IN MANUFACTURING REFRIGERATORS



COMPONENTS	1960	1969	1979
Casters and wheels	3,475,000	5,356,100	9,350,000
Compressors	3,475,000	5,356,100	9,350,000
Condensers	3,475,000	5,356,100	9,350,000
Defrost controls	1,737,500	2,678,050	4,675,000
Evaporators	3,475,000	5,356,100	9,350,000
Fans	4,517,500	6,962,930	12,155,000
Fan motor in defrost models	1,737,500	2,678,050	4,675,000
Fasteners	1,077,250,000	1,660,391,000	2,898,500,000
Frost plates	1,042,500	1,606,830	2,805,000
Gaskets (magnetic insert)	695,000	1,071,220	1,870,000
Handles	5,212,500	8,034,150	14,025,000
Heaters	6,255,000	9,640,980	16,830,000
Hinges	9,035,000	13,925,860	24,310,000
Ice trays	5,907,500	9,105,370	15,895,000
Icemakers	486,500	749,854	1,309,000
Isolation mounts, for compressor	10,425,000	16,068,300	28,050,000
Lights	4,170,000	6,427,320	11,220,000
Metering valve in ice tray	486,500	749,854	1,309,000
Nameplates	6,950,000	10,712,200	18,700,000
Plastic parts (not incl. shelf supports & slides)	114,675,000	176,751,300	308,550,000
Shelf supports & brackets	55,600,000	85,697,600	149,600,000
Shelves	10,077,500	15,532,690	27,115,000
Thermostats	5,560,000	8,569,760	14,960,000
3-wire cord set	3,475,000	5,356,100	9,350,000
Trays & drawers (steel & plastic)	8,687,500	13,390,250	23,375,000
Trim, metal (ft)	90,350,000	139,258,600	243,100,000
Tubing (ft) aluminum	62,550,000	96,409,800	168,300,000
copper	45,175,000	69,629,300	121,550,000
steel	76,450,000	117,834,200	205,700,000
Wiring harness	13,900,000	21,424,400	37,400,000
MATERIALS			
Aluminum (lbs) (does not incl. tubing)	11,467,500	17,675,130	30,855,000
Glass (lbs)	8,340,000	12,854,640	22,440,000
Insulation (foam & fiberglass) (lbs)	29,537,500	45,526,850	79,475,000
Paint (sq ft) of metal	246,725,000	380,283,100	663,850,000
Plastic (lbs)	37,182,500	57,310,270	100,045,000
Porcelain enamel (sq ft) of metal	118,150,000	182,107,400	317,900,000
Steel (lbs) (does not include steel tubing or steel wire)	611,600,000	942,673,600	1,645,600,000
Wire (ft) copper	264,100,000	407,063,600	710,600,000
(lb) steel	15,985,000	24,638,060	43,010,000
NUMBER OF UNITS (000's)	3,475	5,356	9,350

Source: Appliances, p.97, Oct. 1970.

10 appliances must be processed to obtain the same ferrous content as 1 automobile. Further complications with appliances occur as there is no central, continuous course of supply to the processor, as the auto wrecker supplies for hulks.

As a result, the economic value of obsolete appliances is extremely low. The NIPCC report cited a survey in early 1971 in which only three processors out of 42 contacted in 14 municipalities would buy a washing machine and refrigerator, at prices ranging from $0.20 to $1.50.(18) Even shredding operations, which have the best opportunity to produce quality scrap from appliances economically, will pay only $8-10 per ton, the equivalent value of $0.80 to $1.00 per appliance. The collection and transportation of appliances to processors for payment at these rates is therefore economically prohibitive.

Based on today's economics, there does not appear to be any real opportunity for increased recycling of obsolete appliances. One solution periodically proposed involves the burying of appliances at one location, such as landfills, open pits, abandoned mines, and similar sites, so that they can be "mined" at a later date. While this preserves the opportunity to recycle, as compared to burial with all other municipal waste in landfill, it does not appear to be a practical approach worth the extra effort, as it is unlikely that future needs or values will justify recovery costs.

However, as municipal landfill is depleted and/or shredder operations require additional feed, more appliances will undoubtedly be recycled. In addition, central collection, separation, and processing of municipal solid waste i.e., establishment of optimum disposal and recycling facilities, could cut down on handling costs.

Potential Supply

It is extremely difficult to accurately determine the amount of potential iron and steel scrap available for recycling. Iron and steel scrap has three basic sources, as previously noted. Home scrap, that which is generated in the manufacture of iron and steel products, is roughly the difference between ingot production and shipped product for steel, and metal cast versus shipments for iron and steel castings, allowing for inventory changes, in both scrap and finished products. In steel, the yield approximates 70 percent, and in castings, about 60 percent. Thus, in any given year, these factors can be used to approximate the amount of home scrap generated. This scrap, however, is of little consequence to our considerations of ferrous solid waste, as it typically is consumed by the producing plants. It is of importance however, because scrap is scrap and an increase in generation of home scrap, which has been occurring in the basic steel industry, offsets other scrap usage.

The second type of scrap, prompt industrial scrap, also is of little consequence to our study, other than the replacement factor noted. In general, prompt industrial scrap is all recycled, as it is a prime, known quality type of raw material. On average, about 20 percent of all steel shipments and 5 percent of all castings shipments in a given year is available as prompt industrial scrap during that year.

This leads to obsolescent scrap, the product of ferrous solid waste. Determination of its new supply each year and the already existing inventory of such products is a complex, imprecise calculation. Battelle has made a general estimate of both; its value and the assumptions made appear in the following tables Tables IV-25 and IV-26. It is cautioned that these estimates are made only as a rough approximation of magnitude. To do otherwise is not within the scope of this study. However, even if substantial error exists, it would have little effect on our general conclusions that a significant inventory of obsolescent scrap exists, one which is added to each year.

It is therefore estimated that by year end 1969, the inventory of obsolescent scrap available for recycling approximated 750 million tons. The calculated amount on hand approximates a 30-year supply of obsolescent scrap at 1969's high consumption rate. In addition, it is further calculated that only 60 percent of the new supply each year is recycled. While this is a relatively high rate compared to other materials, the available new supply not consumed simply adds to the already large reservoir resulting in a waste of a potential valuable resource, an addition to our inventory of solid waste problems, a target for ecological attack, and an affront to our aesthetic senses.

TABLE IV-25. IRON AND STEEL INVENTORY, 1969
(million net tons)

	1881-1955	1956-1969	1881-1969
Steel Shipments(1)	+2,202	1,113	3,315
Foundry Shipments(2)	+ 712	223	935
Net Exports (Imports)(3)	- 120	(54)	66
Total Iron and Steel Supply	+2,794	1,390	4,184
Prompt Industrial Scrap(4)	- 332	243	575
Iron and Steel in Products	+2,462	1,147	3,609
Net Exports Fabricated Products(5)	- 71	40	111
Domestic Consumption--Iron and Steel in Products	+2,391	1,107	3,498
Nonrecoverable Losses(6)	- 351	166	517
Potential Recovery	+2,040	941	2,981
Obsolete Scrap Withdrawals(7)	- 608	292	900
Inventory	+1,432	649	2,081
Inventory as of January 1, 1881	+ 60		60
Net Inventory	1,492	649	2,141
Still in Use(8)	956		1,391
Obsolete	537		750

Sources: Pre-1881, 1881-1955. A survey and analysis of the supply and availability of obsolete iron and steel scrap. Columbus, Battelle Memorial Institute, Dec. 31, 1957.

1956-1969 – Battelle-Columbus estimates based on

(1) AISI, Annual Statistical Reports

(2) Bureau of Census

(3) AISI, Annual Statistical Reports

(4) 17.5% x Total Iron and Steel Supply; steel generation ratio at 20%, castings at 0.5%

(5) This number is difficult to estimate, as trade statistics are based on dollar volume. In recent years, the values have tended to offset each other; however, even a substantial estimating error will have little effect on the analysis

(6) .15 x Domestic Consumption; the Battelle study cited above estimated 15% of all potential obsolete scrap would be unavailable due to product size or usage; corrosion, abrasion, and process losses; and war and shipping losses

(7) Purchased scrap, i.e., mill receipts less shipments + exports - .95 Prompt Industrial Scrap - scrap imports

(8) .65 (Net inventory, 12/31/69); approximately 20-year cycle

TABLE IV-26. NEW SUPPLY IRON AND STEEL SCRAP POTENTIAL, 1970

Calculations	Life Cycle, years	Average for Years	Domestic Consumption, million net tons
NEW SUPPLY = Iron and Steel Products Available, for the first time, 1970			
I. **Obsolescent Available**			
A. Steel Mill Products			
from Agriculture Markets	15	1954-1956	1.2
Automotive	10	1959-1961	13.8
Construction	40	1928-1932	4.7
Consumer Durables	15	1954-1956	4.0
Containers	1	1969-1970	7.4
Machinery	20	1949-1951	5.2
Rail Transportation	25	1944-1946	4.8
All Other, excluding exports	20	1949-1951	22.2
Imports	20	1949-1951	1.2
			64.5
B. Iron and Steel Castings			
from Gray and Malleable Iron	15	1954-1956	14.4
Steel	20	1949-1951	1.6
Import (Export) Balance	15-20	1949-1956	(0.1)
			15.9

C. Product yield from shipments = Steel Mill Products at 80 percent; Ferrous Castings at 95 percent

D. Unrecoverable Losses = 15 percent

E. Calculated Obsolete Scrap Availability (Steel Mill Products + Iron and Steel Castings) (Yield from Shipments) (Recoverable) = [(64.5)(.80) + 15.9 (.95)] [.85] = 56.7 million net tons

II. Prompt Industrial Scrap Availability

A. Steel Mill Products = 1970 Domestic Consumption, 97.1 million net tons x Scrap Generation, Ratio (.20) = 19.4 million net tons

B. Ferrous Castings = 1970 Domestic Consumption, 16.3 million net tons x Scrap Generation, Ratio (.05) = .8 million net tons

C. Prompt Industrial Scrap Availability = 19.4 + .83 = 20.2 million net tons

III. Total Scrap Availability, i.e., New Supply = 56.7 + 20.2 = 76.9 million net tons

IV. Total Purchased Scrap (Receipts-Shipments) + (Exports) = 44.5 million net tons

V. Available and Not Recycled = 32.4 million net tons, approx 40 Percent of Available.

Source: Battelle-Columbus Estimates.

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CHAPTER V

MARKETS FOR IRON AND STEEL SCRAP

Iron and steel scrap consumption is concentrated in two basic industries: the steel industry and the iron and steel castings industry. In 1970, 85.6 million tons were consumed domestically, with the steel industry using about 80 percent and the foundry industry consuming the bulk of the remaining 20 percent. In addition, approximately 11 million tons were exported. Scrap consumption by market for selected years appears in Table V-1 below:

TABLE V-1. MARKETS FOR IRON AND STEEL SCRAP, 1950-1969
(million tons)

	1950		1955		1960		1965		1969	
	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent	Tons	Percent
Steel Industry(1)	53.9	78.1	65.3	75.5	53.2	71.5	69.8	73.6	76.6	73.8
Ferrous Foundry Industry(2)	14.9	21.6	16.1	18.6	13.2	17.7	18.9	19.9	18.2	17.5
Export	.2	.3	5.1	5.9	8.0	10.8	6.2	6.5	9.0	8.7
Total Scrap Consumption	69.0	100.0	86.5	100.0	74.4	100.0	94.9	100.0	103.8	100.0

(1) Manufacturers of steel ingots and castings.
(2) Manufacturers of steel castings, iron foundries, and miscellaneous users.

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, years indicated.

While other markets exist and new uses for iron and steel scrap are currently under study, their impact on consumption will be minor, at least in the short run. It is therefore appropriate to examine the current markets for scrap and their prospects.

The Steel Industry

The primary market for iron and steel scrap is the world steel industry. Steel production is heavily concentrated in three countries accounting for 56 percent of the total 632 million net tons produced in 1969.* They are: the United States, 141 million - 22.4 percent; the Soviet Union, 122 million - 19.2 percent; and Japan, 91 million - 14.3 percent. EEC countries, with West Germany dominating, produced another 118 million tons - 18.7 percent. The only other major steel producer is the United Kingdom, 30 million tons - 4.7 percent. In total, these countries produced 80 percent of the total world steel in 1969.

World steel production has grown by over 30 percent during the last five years (1964 to 1969), with an anticipated annual growth rate approaching 4 percent through 1985. The United States has not shared significantly in this growth. Production increased only 11 percent over the same period, and an annual growth rate of under 3 percent is anticipated through 1985. U.S. world dominance is shrinking significantly. In 1950, 47 percent of the world's steel was produced in this country. By 1960, this had decreased to 26 percent, and by 1980 a share of less than 20 percent is expected. It further appears that this nation's position as the world's leading producer will be lost to the Soviet Union, with Japan a close third within the next ten years. Therefore, it is essential to consider both the domestic and foreign markets for iron and steel scrap if a fuller recycling of ferrous solid waste through processing into scrap is to be achieved.

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*While 1970 statistics are available, 1969 has been chosen as more representative due to the adverse effects of the automotive strike in the United States in 1970, steel's largest consumer.

World steel production and U.S. share are shown in Figures V-1 and V-2 below.

Figure V-1. WORLD STEEL PRODUCTION 1950-1980

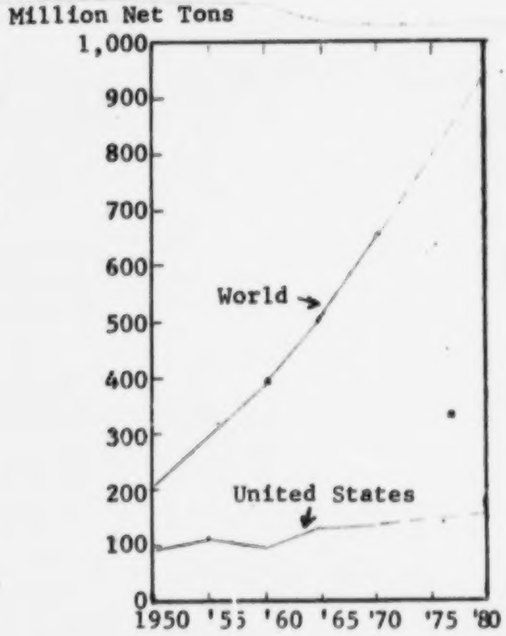
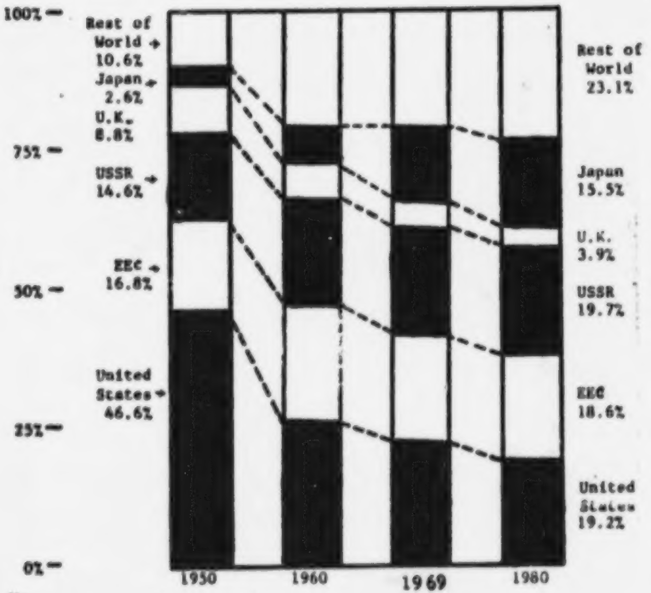


FIGURE V-2. U.S. SHARE OF WORLD STEEL PRODUCTION



Source: 1950-1969. Annual statistical reports. New York, American Iron and Steel Institute. 1980. 33 Magazine, p.70, Sept. 1970.

While export markets for iron and steel scrap took over 20 percent of purchased scrap in 1970, the main emphasis for increased usage must lie with the domestic iron and steel industries. And the primary consideration is the steel industry, which consumes 80 percent of domestic scrap.

The American Steel Industry

The steel industry has played a dominant role in the development of this nation to the world's highest standard of living that we enjoy today. The first successful iron works in the United States was started at Saugus, Massachusetts, in 1645, but it was not until over 200 years later with the introduction of the

Kelly and Bessemer pneumatic acid steelmaking processes that steel became a reality. By 1871, steel production had reached an unprecedented 80,000 net tons. But it was not until the late 1880's with commercialization of the Siemens-Martin basic open-hearth process that steel became a material on which to build a nation. In 1890, close to 5 million tons were being produced. The Bessemer process, limited to iron ores of low phosphorous content and limited in its use of scrap as a metallic input (5 to 15 percent), continued to dominate steelmaking until 1908 when it was surpassed by basic open-hearth steelmaking, with its greater flexibility, increased utilization of scrap (40 to 50 percent), and ability to use higher phosphorous domestic ores. Steel production in that year had grown to over 15 million tons.

Growth continued at a rapid pace to 35 million tons in 1915, 50 million tons in 1925, 75 million tons in 1941, over 100 million tons in 1951, and to the record year of over 140 million tons in 1969. Steel production and shipment data for the period 1950-1970 are shown in Table V-33 at the end of this chapter. The open-hearth process remained the dominant steelmaking method throughout this period until 1970 when its leadership was lost to the basic oxygen process (BOP) using a 30 percent scrap charge. Meanwhile, electric furnace steelmaking, utilizing almost a 100 percent scrap metallic input, has grown from less than one million tons in 1940 to approximately 20 million tons in 1970. (These changes in steelmaking methods and their significance for scrap consumption will be developed in a later section.)

Annual sales of the steel industry approximate $19 billion, ranking it third among all manufacturing industries. Employment approaches 500,000 persons, ranking it second. Capital-intensive, it required 75¢ of net fixed assets for each dollar of sales in 1970. Capital expenditures since 1960 have exceeded $16 billion and have averaged 15 percent of its net plant account over the same period.

But despite its tremendous size, improved technology and products, and high capital investment, steel is today a troubled industry. From a profit standpoint, iron and steel ranks 40 out of 41 manufacturing industries analyzed annually by First National City Bank of New York, with a return on net worth of 4.4 percent versus 10.1 percent for all manufacturing in 1970. Measured by return on revenues, steel earned 2.7 percent versus 4.6 percent for all manufacturing in that same year. In addition to this limited profitability, this bulwark of American industry is plagued by a low-growth rate, increasing production costs, threats to its current markets by competitive materials, and a significant import balance in steel mill products. Thus, this foremost market for ferrous scrap has its problems.

Industry Structure. The American steel industry is composed of approximately 110 companies, of which 21 are fully integrated (coke ovens, blast furnaces, steelmaking furnaces, and mill product finishing facilities); 5 operate coke ovens and/or blast furnaces; 1 has no coke ovens but operates blast furnaces, steelmaking furnaces and finishing facilities; and the remaining 80 companies operate only steelmaking furnaces and/or finishing facilities with electric furnace steelmaking predominating.(1) These "steelmaking furnaces only" produce less than 10 percent of the nation's output, but with their electric furnaces, are a significant outlet for ferrous scrap.

Three companies (United States Steel, Bethlehem Steel, and Republic Steel) dominate the industry, producing close to 50 percent of 1970's 131 million ingot tons. Five additional companies (National, Armco, Jones & Laughlin, Inland, and Youngstown Sheet & Tube) account for 25 percent of total output. Steel production is therefore concentrated in the so-called "Big Eight", accounting for 75 percent of 1970 production. Adding the next 19 companies ranked by ingot production shows over 90 percent of this nation's steel output is concentrated in 27 of over 100 companies.

Geographic distribution of raw steel production by major states is shown in Figure V-3. Production is heavily concentrated in the Middle Atlantic and East North Central states, which produce over 75 percent of total steel. The 14 states indicated in the map below produce over 95 percent of total raw steel in the United States.

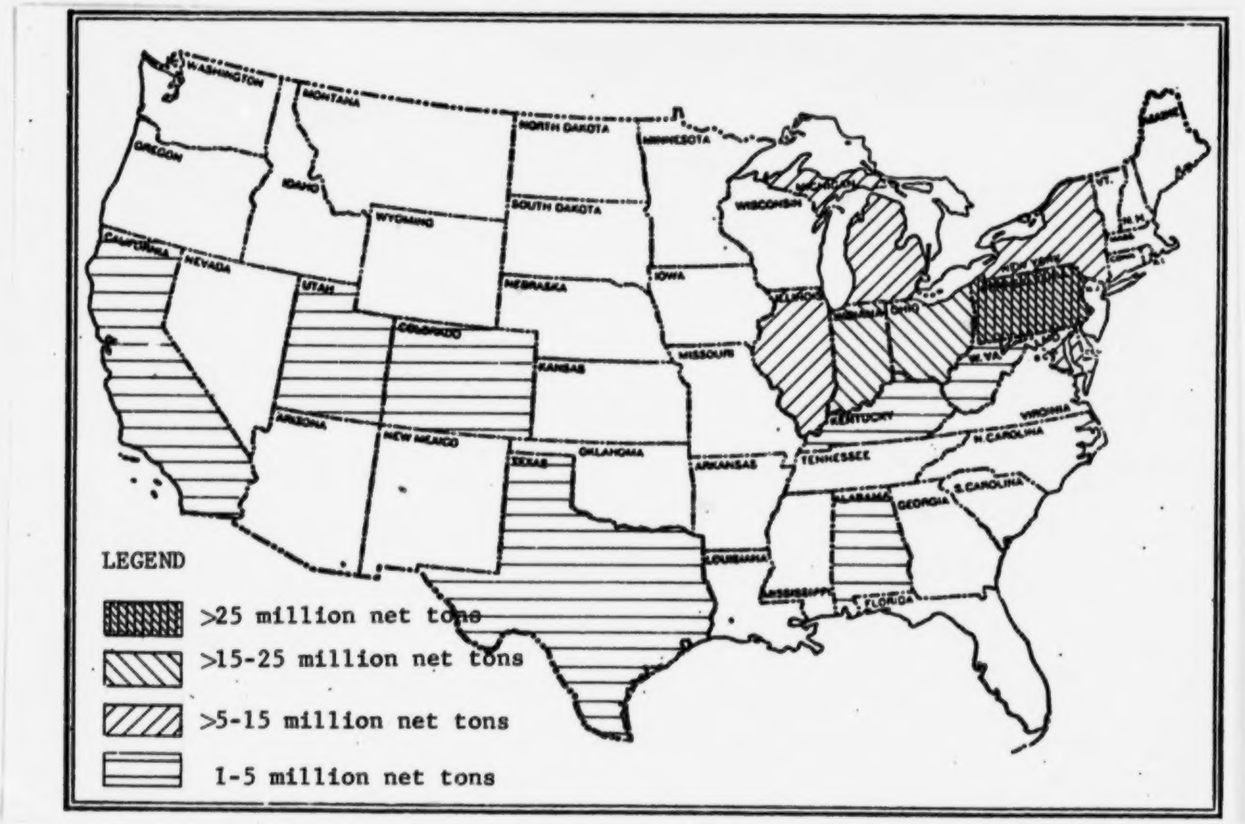

WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
WISCONSIN
MICHIGAN
VT.
N.H.
CALIFORNIA
NEVADA
IOWA
NEW YORK
UTAH
NEBRASKA
ILLINOIS
INDIANA
OHIO
COLORADO
KANSAS
MISSOURI
W. VA
KENTUCKY
VIRGINIA
ARIZONA
NEW MEXICO
N. CAROLINA
TEXAS
OKLAHOMA
ARKANSAS
TENNESSEE
ALABAMA
GEORGIA
S. CAROLINA
LOUISIANA
MISSISSIPPI
FLORIDA
LEGEND
>25 million net tons
>15-25 million net tons
>5-15 million net tons
1-5 million net tons

Figure V-3. RAW STEEL PRODUCTION BY GEOGRAPHIC AREA

Source: Battelle-Columbus estimates, based on AISI data.

Among the structural changes taking place in the industry with implications for ferrous scrap consumption are:

(1) Increased importance of regional "mini-mills", defined as 50,000 to 250,000 tons annual capacity electric furnace steelmaking operations, many with continuous casting, producing simple steel products for a local market. There are approximately 40 such mills in the U.S. today with an estimated 5 percent of total industry capacity. (See map, Figure V-4.)

(2) Continued domination by the larger steel companies through assimilation and/or deterioration of the medium-sized (400,000 to 2,000,000 ton capacity) producers.

(3) A gradual phasing out of older mills and low profit product lines.

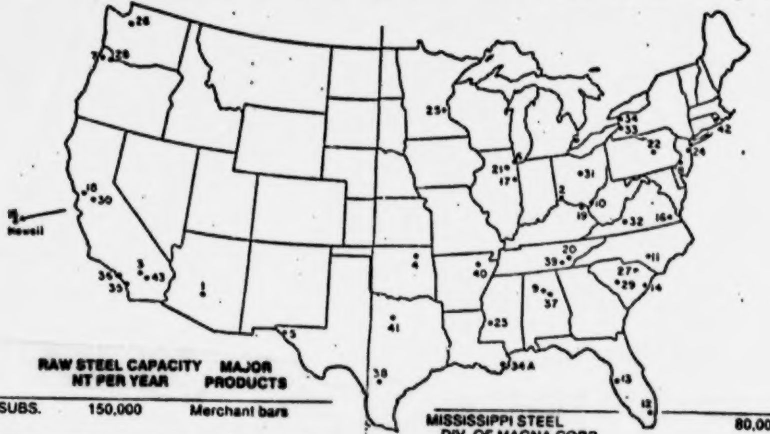
(4) Increased study of establishing mills abroad to counter foreign competition and improve profits.

(5) Decisions regarding the alternative uses of limited capital for steelmaking through further commitment to the iron ore route, e.g., increased development of iron ore properties and beneficiation and/or direct reduction facilities, required coke oven rebuilds, enlargement of blast furnace capacity, and increased domination of the basic oxygen process, versus the scrap route via electric furnace steelmaking and increased scrap utilization techniques such as preheating.

(6) Further diversification into non-steel areas by steel companies.

Industry Growth. Increased recycling of ferrous solid waste is dependent to a great extent on increased demand for iron and steel scrap by the steel industry. A key determinant to this demand is the demand for steel itself and the associated growth in scrap demand for supplying the required metallic input.

FIGURE V-4. MINI STEEL PLANTS[1] IN THE UNITED STATES (as of January 1971)



	COMPANY AND LOCATION	RAW STEEL CAPACITY NT PER YEAR	MAJOR PRODUCTS
1	ALLISON STEEL, GETZ BROS. SUBS. Tempe, Arizona	150,000	Merchant bars
2	AMERICAN COMPRESSED STEEL Cincinnati, Ohio	12,000	Merchant bars
3	AMERON STEEL PRODUCING DIV. Etiwanda, California	160,000	Merchant bars & coils
4	ARMCO STEEL CORP. Sand Springs Works Sand Springs, Oklahoma	300,000	Merchant bars, special structurals
5	BORDER STEEL MILLS El Paso, Texas	140,000	Merchant bars
6	BORG-WARNER, CALUMET STEEL DIV. Chicago Heights, Illinois	180,000	Merchant, special bars, light structurals
7	CASCADE STEEL ROLLING MILLS McMinnville, Oregon	130,000	Merchant bars
8	CF&I STEEL CORP. ROEBLING PLANT, Burlington County, New Jersey	200,000	Wire
	CONNORS STEEL DIV., H.K. PORTER CO.		
9	Birmingham, Alabama	200,000	Merchant bars & structurals
10	Huntington, West Virginia	150,000	Merchant bars & structurals
	FLORIDA STEEL		
11	Croft, North Carolina	100,000	Merchant bars
12	Indiantown, Florida	90,000	Merchant bars
13	Tampa, Florida	200,000	Merchant bars & structurals
14	GEORGETOWN STEEL Georgetown, South Carolina	400,000	Merchant bars
15	HAWAIIAN WESTERN STEEL Ewa, Hawaii	50,000	Merchant bars
16	INTERCOASTAL STEEL Chesapeake, Virginia	80,000	Merchant bars
17	JONES & MC KNIGHT CORP. Kankakee, Illinois	100,000	Merchant bars
18	JUDSON STEEL CORP. Emeryville, California	75,000	Merchant bars
19	KENTUCKY ELECTRIC STEEL Ashland Kentucky	120,000	Merchant bars & structurals
20	KNOXVILLE IRON CO. Knoxville, Tennessee	100,000	Merchant bars
21	LEMONT MANUFACTURING CO. SUBSIDIARY CECO CORP. Lemont, Illinois	240,000	Merchant bars & structurals
22	MILTON MANUFACTURING CO. DIVISION CECO CORP. Milton, Pennsylvania	170,000	Merchant bars & structurals
23	MISSISSIPPI STEEL DIV. OF MAGNA CORP. Jackson, Mississippi	80,000	Merchant bars
24	NEW JERSEY STEEL CORP. Sayreville, New Jersey	120,000	Merchant bars
25	NORTH STAR STEEL St. Paul, Minnesota	300,000	Merchant and special bars
26	NORTHWEST STEEL ROLLING MILLS Seattle, Washington	100,000	Merchant bars
27	NUCLEAR CORP. OF AMERICA EASTERN CAROLINA STEEL DIV. Darlington, South Carolina	120,000	Merchant bars
28	OREGON STEEL MILLS Portland, Oregon	350,000	Merchant bars & plate
29	OWEN ELECTRIC STEEL CO. Cayce, South Carolina	100,000	Merchant bars
30	PACIFIC STATES STEEL CORP. Union City, California	400,000	Bars & structurals
31	POLLAK STEEL Marion, Ohio	100,000	Merchant bars
32	ROANOKE ELECTRIC STEEL Roanoke, Virginia	170,000	Merchant bars
	ROBLIN STEEL		
33	Dunkirk, New York	100,000	Special bars & wire rod
34	Tonawanda, New York	300,000	Special bars and wire rod
34A	ROSS STEEL WORKS Amite, Louisiana	100,000	Merchant bars
35	SOULE STEEL Long Beach, California	100,000	Merchant bars
36	SOUTHWEST STEEL ROLLING MILLS SUB. AUTOMATION IND. Los Angeles, California	100,000	Merchant bars
37	SOUTHERN ELECTRIC STEEL DIVISION OF CECO CORP. Birmingham, Alabama	85,000	Merchant bars
38	STRUCTURAL METALS Sequin, Texas	90,000	Merchant bars
	TENNESSEE FORGING STEELS		
39	Harriman, Tennessee	120,000	Merchant bars
40	Newport, Arkansas	90,000	Merchant bars
41	TEXAS STEEL Ft. Worth, Texas	150,000	Merchant bars
42	WASHBURN, WIRE CO. Phillipsdale, Rhode Island	120,000	Hot rolled rod & wire
43	WITTIMAN STEEL Fontana, California	40,000	Merchant bars
	TOTAL TONNAGE:	6,582,000	

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[1] The major criteria used in designating a steel plant as "mini" is (a) that raw steelmaking capacity be no more than 400,000 net tons per year, (b) products made shall not be speciality steels, flat rolled, or forgings exclusively.

[2] Electric furnaces unless indicated otherwise by OH for open hearths.

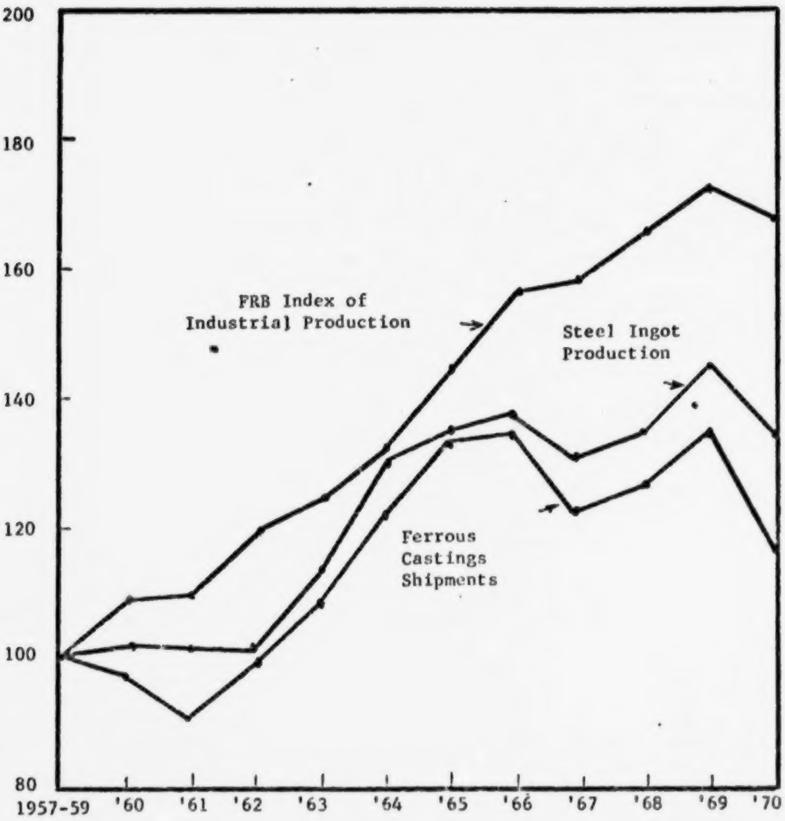
[3] Metallized pellets used or planned.

[4] Oregon Steel's casting arrangement is described as "pressure casting."

Source: 33 Magazine, p.57-59, Mar. 1971.

During the past decade, the American economy, as measured by Gross National Product in constant dollars, has grown at an annual rate averaging 5 percent. Industrial production has grown at a slightly higher rate approaching 6 percent, reflecting productivity increases. The durable manufacturing component of industrial production, comprising the major markets for steel products, has averaged even greater growth. Meanwhile, domestic steel production has grown at a rate slightly in excess of 3 percent. Continuation of these trends is expected, with perhaps the gap between steel growth and that of the economy even widening. (See Figure V-5.)

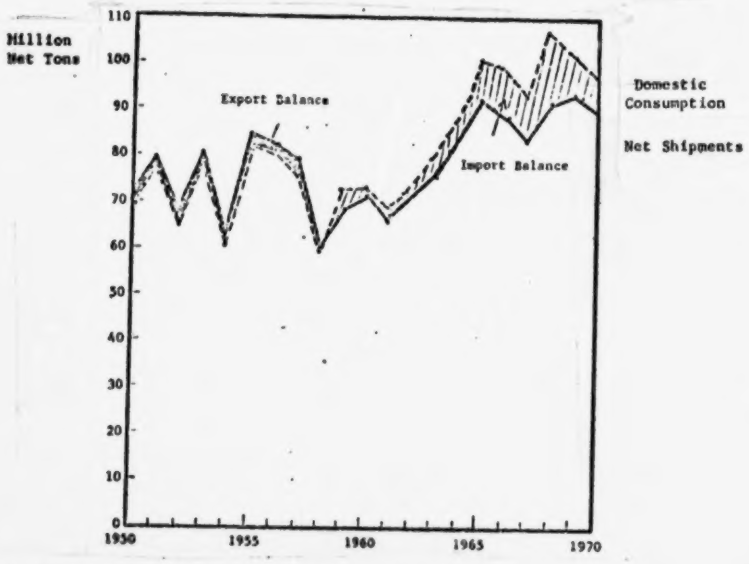
FIGURE V-5. GROWTH OF THE AMERICAN ECONOMY AND MARKETS FOR SCRAP, 1957-1970.



There are at least three distinct causes for the relative lagging growth of the American steel industry. They are:

(1) Disappearance of the historic export balance in steel mill products, the primary cause. As recently as 1957, the steel industry enjoyed a 3.5 million ton export balance. In the following year, the balance shrunk to under a million ton, never to be seen since. Within ten years, the balance had shifted, and imports held a 16 million tons advantage over exports in 1968, almost 17 percent of domestic steel comsumption. Due to voluntary quota levels accepted by Japan and the EEC plus increased foreign demand, the import balance declined to six million tons in 1970 (Figure V-6). However, import upgrading has occurred. Particularly hard-hit are stainless and tool steel producers. The import balance is expected to climb once again to a minimum of 10 million tons per year level. This means not only the loss of 15 million ingot tons to the domestic steel industry, but also the loss of an outlet for approximately 3 million tons of purchased scrap.

FIGURE V-6. DOMESTIC STEEL CONSUMPTION, 1950-1970



Source: Annual statistical reports. New York, American Iron and Steel Institute.

(2) Replacement of steel by competitive materials, such as aluminum, concrete, and plastics.

(3) Increased utilization of lighter steels with improved properties, such as high strength-low alloy steels and "thin-tin" at the expense of conventional steels.

The future growth of the American steel industry is dependent upon five major factors:

(1) The growth of the American economy and its requirements for steel in that growth

(2) The relative proportion of those requirements supplied by domestic producers

(3) Marketing and technological innovations and improvements for increased utilization in current and new uses for steel

(4) Types of products and processing technology, including those affecting the yield of finished product shipments to ingot production (at present, the yield is slightly decreasing, therefore, requiring more raw steel production for the same finished products shipment)

(5) The economic well-being of the steel industry.

Taking these and other factors into consideration Battelle projects steel production averaging 155 million net tons by 1975, 175 million by 1980, and 200 million tons by 1985, an annual growth rate of 2.5 percent. The composition of that production by steelmaking furnace type, of key importance for the scrap component of that steel, will be developed in the next section.

Steelmaking Technology. The two key elements affecting the use of scrap by the steel industry are:

(1) Type of steelmaking furnace employed

(2) Availability and/or cost of competitive materials (pig iron, hot metal, direct reduced ores, etc.) relative to scrap.

Throughout this nation's history, steel has been produced in four types of steelmaking furnaces, each having particular implications on scrap usage. They are the Bessemer converter, the open-hearth furnace, the Basic Oxygen furnace, and the electric furnace. While other types have been used, these four have **dominated.**

The Bessemer converter, a pneumatic bottom-blown acid steelmaking furnace, dominated early steelmaking. However, it was limited to both iron ores of low phosphorous content and a low scrap proportion (5 to 15 percent) of its metallic input. Bessemer production peaked in 1906 at 13 million tons, was surpassed by open-hearth steelmaking two years later, and has steadily decreased in importance since. The last year that Bessemer production exceeded 1 million tons was 1960. By 1970, the Bessemer converter had virtually disappeared from the American steelmaking scene.

Basic open-hearth steelmaking, with its greater flexibility, ability to use higher phosphorous domestic ores , and increased utilization of scrap (40 to 50 percent of the metallic charge) dominated American steelmaking for the next 60 years. During this period however, the impact of two other steelmaking processes was being felt.

Electric furnace steelmaking, with its flexibility in product output and operation, economics for relatively low tonnage outputs, and independence of heavy capital investment in blast furnace facilities for a metallic source (uses 95 percent plus scrap charge), was originally used predominately for alloy and stainless steels. By the late 1930's, over a million tons was being produced annually by this method. During the following decade, its economics for carbon steel production were improved. In 1969, over 20 million tons was produced in electric furnaces, of which 65 percent were carbon steels.

However, it has been the Basic Oxygen Process which has had the greatest impact on steelmaking and scrap utilization in the past decade. This pneumatic top blown steelmaking furnace's greatest attribute is its speed, producing at a rate and cost significantly below that of traditional open-hearth steelmaking. Making its debut on the American scene only 16 years ago in 1955, it accounted for less than 5 percent of total ingot production 10 years ago in 1961. But during the past decade, it grew both as new capacity was required and as replacement capacity for open-hearth steelmaking. In 1970, it surpassed the open-hearth as the primary steelmaking furnace, producing almost 50 percent of last year's raw steel.

It is expected that both basic oxygen and electric steelmaking will continue to increase their share of the raw steel produced in this country as indicated in the table shown below.

TABLE V-2. U.S. INGOT PRODUCTION BY TYPE OF FURNACE

	Total	Open Hearth		Basic Oxygen		Electric	
Year	Million Tons	Million Tons	Percent	Million Tons	Percent	Million Tons	Percent
1950	96.8	90.8*	93.8	--	--	6.0	6.2
1955	117.0	108.7*	92.9	.3	.3	8.0	6.8
1960	99.3	87.6*	88.2	3.3	3.4	8.4	8.5
1965	131.5	94.8*	72.1	22.9	17.4	13.8	10.5
1970	131.5	48.0	36.5	63.3	48.1	20.2	15.4
1975	155.0	40.0	25.8	82.0	52.9	33.0	21.3
1980	175.0	25.0	14.3	105.0	60.0	45.0	25.7
1985	200.0	14.0	7.0	127.0	63.5	59.0	29.5

* Bessemer included: 1950 - 4.5 million tons; 1955 - 3.3 million tons; 1960 - 1.2; 1965 - .6.

Source: 1950-1970. Annual statistical reports. New York, American Iron and Steel Institute; and Battelle-Columbus estimates.

The basic raw material for steelmaking is, of course, iron. Iron is available from two sourses, i.e., (1) iron ore, reduced in the blast furnace and known as pig iron or hot metal, or partially reduced by a direct reduction process and fed directly to the steelmaking operation or the blast furnace; and (2) iron and steel scrap, remelted in the blast furnace, or upgraded and conditioned by physical means, or added directly to the steelmaking operation.

Many factors affect the choice of iron source. Among the most prominent are technological considerations, such as heat balance, charging procedures, steel quality being produced, energy sources, iron source quality requirements, density requirements, and other operating practices; availability of hot metal and/or pre-reduced ores as a substitute/complement to scrap source; and costs of capital, raw materials, and production relative to alternative metallic sources.

At present, these and other factors have dictated typical steelmaking charges as follows:

Process	Pig Iron	Scrap
Basic Oxygen	70 percent	30 percent
Open Hearth	55 percent	45 percent
Electric	- -	100 percent

As can been seen in Table V-3, these charge ratios have been maintained over the past five years, with slight yearly variations, although some increase has taken place in open-hearth scrap usage, due primarily to increased roof lance oxygen injection.

TABLE V-3. COMPARISON OF SCRAP AND PIG IRON USED IN STEELMAKING FURNACE CHARGES (in percentages)

Type of Furnace	1965 Scrap	Pig Iron	1966 Scrap	Pig Iron	1967 Scrap	Pig Iron	1968 Scrap	Pig Iron	1969 Scrap	Pig Iron
Basic Oxygen Converter	29.6	70.4	29.0	71.0	29.4	70.6	29.1	70.9	29.9	70.1
Open Hearth	41.6	58.4	41.5	58.5	41.6	58.4	44.0	55.9	45.0	55.0
Electric	99.7	0.3	98.4	1.6	97.9	2.1	97.4	2.6	98.6	1.4
Total	43.8	56.2	43.1	56.9	42.6	57.4	44.4	55.6	45.3	54.7

Source: Yearbook. 31st ed. Washington, Institute of Scrap Iron and Steel, 1970. p.36.

In total, the scrap proportion has remained fairly constant (Table V-4), although a sharp increase was noted in 1969. This increase was primarily due to a lack of hot metal availability during that record production year, making steel producers more dependent on increased scrap consumption for iron input. Total consumption of both pig iron and scrap has stabilized at about 1.1x ingot production.

TABLE V-4. CONSUMPTION OF SCRAP AND PIG IRON, STEELMAKING FURNACES*

(thousand net tons)

Year	Scrap	Pig Iron	Total	Scrap Percent of Total	Ratio: Total to Ingot Production
1965	62,959	90,809	143,768	43.8	1.09
1966	63,452	83,600	147,052	43.1	1.10
1967	59,604	80,152	139,756	42.6	1.10
1968	63,581	79,771	143,352	44.4	1.09
1969	69,655	84,018	153,673	45.3	1.09

* Basic oxygen, open hearth, and electric furnaces only.

Source: Based on data from AISI Annual Statistical Reports, 1969 and 1970, p 54.

Much of the decline in the fortunes of the scrap industry has been blamed on the advent of the basic oxygen furnace, with its 30 percent scrap charge,at the expense of open hearth steelmaking which uses 45 percent scrap. While this is obviously true if all things else are held equal, the table below shows the relative effect on total scrap consumption of the change in furnace mix and scrap proportion. The conclusion can therefore be drawn that these factors allowed scrap to hold its own, and actually increase somewhat over the past decade.

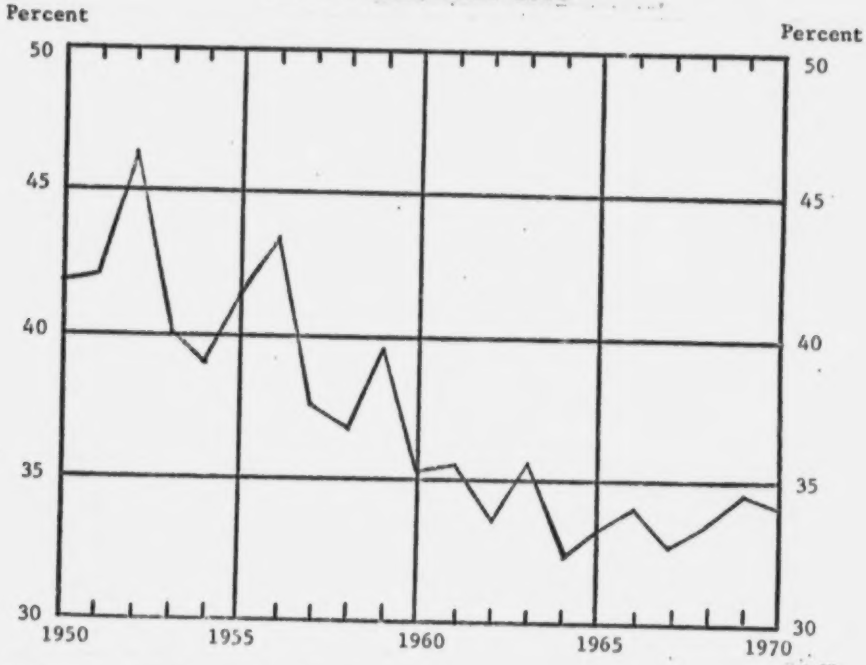
TABLE V-5. EFFECT OF STEELMAKING FURNACE TECHNOLOGY ON SCRAP CONSUMPTION, 1960-1970

Year	Basic Oxygen		Open Hearth		Electric		Total	
	% Steel Production	% Scrap of Charge	% Steel Production	% Scrap of Charge	% Steel Production	% Scrap of Charge	% Steel Production	% Scrap of Charge
1960	3.3	28.1	87.0	41.7	8.4	96.4	100.0	45.3
1961	4.0	27.9	86.2	40.9	8.8	97.3	100.0	45.0
1962	5.6	26.9	84.3	40.3	9.2	97.8	100.0	44.5
1963	7.8	28.0	81.3	41.0	10.0	98.0	100.0	45.3
1964	12.1	30.6	77.2	41.2	9.9	97.9	100.0	45.2
1965	17.4	29.6	71.6	41.6	10.5	99.7	100.0	45.5
1966	25.3	29.0	63.4	41.5	11.0	98.4	100.0	44.4
1967	32.7	29.4	55.7	41.6	11.6	98.0	100.0	44.2
1968	37.1	29.1	50.1	44.1	12.8	97.4	100.0	45.4
1969	42.7	29.9	43.2	45.1	14.1	98.6	100.0	46.2
1970	48.1	30.0	36.5	45.0	15.4	99.0	100.0	46.0

Source: Based on Raw steel production by type of furnace, and, Consumption of scrap and pig iron by type of furnace. Annual statistical reports. New York, American Iron and Steel Institute.

While total scrap consumption therefore has maintained a relatively stable proportion of total ferrous input to iron and steelmaking, the purchased scrap portion has shown a significant decline.* During the period 1950-1956, purchased scrap accounted for 42 percent of the total scrap consumed versus 33.5 percent for the period 1964-1970. Thus, while total steel production increased 35 percent over the period 1950-1979, and total scrap consumption increased 30 percent, purchased scrap increased only 8 percent. These trends are shown by the following two figures.

FIGURE V-7. PURCHASED SCRAP PERCENT OF TOTAL SCRAP CONSUMPTION, 1950-1970



Source: Based on Table V-6.

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* Statistics are not currently available on the actual amounts of purchased and produced scrap consumed; only total consumption, total receipts from all sources, production, shipments, and inventories. It has been assumed for purposes of this analysis that Purchased Scrap = Receipts - Shipments. It is recognized that this calculation does not insure complete accuracy relative to consumption, due to inventory and other changes. However, the assumption that total Purchased and Produced approximate Consumption appears valid (Table V-6); since 1950, the deviation between Consumption and Total as derived has exceeded 2 percent on only 2 occasions, both during inventory build-up.

FIGURE V-8. RAW STEEL PRODUCTION AND SCRAP CONSUMPTION, 1950-1970.

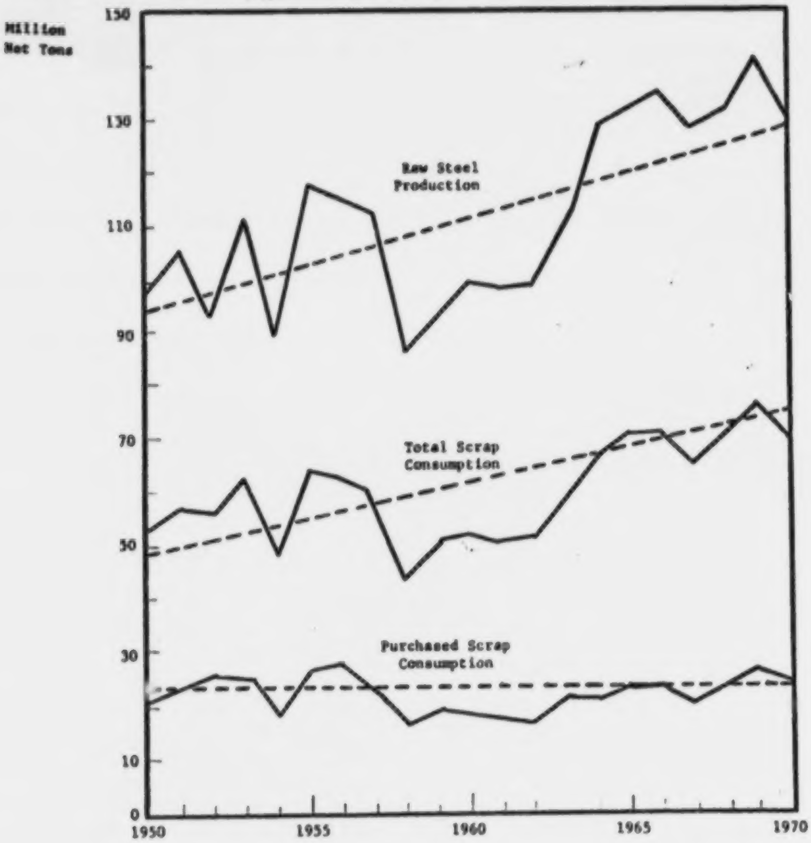


TABLE V-6. PURCHASED AND PRODUCED SCRAP IN STEEL INDUSTRY (Thousand Net Tons)

Year	Purchased Scrap	Produced Home Scrap	Total Purchased and Produced	Purchased of Total Purchased and Produced (percent)	Deviation of Total Purchased and Produced from Consumption (percent)
1950	22,261	31,006	53,266	41.8	.9
1951	23,995	32,974	56,969	42.1	1.7
1952	25,785	29,937	55,722	46.3	4.8
1953	24,703	37,118	61,821	40.0	.6
1954	18,711	29,290	48,001	39.0	.1
1955	26,367	37,407	63,774	41.3	.2
1956	27,500	35,888	63,388	43.4	.4
1957	22,632	36,949	59,582	37.5	2.7
1958	16,360	28,173	44,533	36.7	1.3
1959	19,925	30,481	50,406	39.5	.4
1960	18,173	33,310	51,483	35.3	1.2
1961	17,890	32,564	50,454	35.5	.8
1962	16,801	34,088	50,889	33.6	.5
1963	20,635	37,406	58,041	35.6	.9
1964	21,273	44,556	65,829	32.3	.9
1965	23,107	46,682	69,789	33.1	--
1966	24,038	46,566	70,604	34.0	.7
1967	21,300	43,854	65,154	32.7	.4
1968	23,514	46,679	70,193	33.5	.2
1969	25,985	49,193	75,178	34.6	2.0
1970	24,012	46,359	70,371	34.1	1.6

Source: 1960 and 1970 AISI Annual Statistical Report.

The decline in the purchased scrap proportion of total scrap consumption can be traced to the increased generation of home scrap over this period. Mills, in essence, became greater suppliers of scrap to themselves. Yield, the amount of finished steel shipments from ingot production, provides one measure of this increased home scrap generation. While inventory shifts, shipping patterns, and changes in processing and product mix, make this measure rather crude for year-to-year analysis, certain patterns do emerge over time. The lower yields taking place over the past 20 years are shown below (Table V-7).

TABLE V-7. CALCULATED YIELDS OF STEEL SHIPMENTS OF INGOT PRODUCTION, 1950-1969

Years	Raw Steel Production (thousand net tons)	Finished Steel Shipments (thousand net tons)	Yield (percent)
1950-1954	495,126	367,470	74.2
1955-1959	523,668	377,154	72.0
1960-1964	531,961	368,327	69.2
1965-1969	665,500	452,291	68.0

Source: Annual statistical reports. New York, American Iron and Steel Institute.

Another approach that indicates increased home scrap generation can be seen from a comparison of scrap produced by the mills and product shipments. Again, averages have been used, as year to year figures allow distortion of the pattern Table V-8).

TABLE V-8. PRODUCED SCRAP TO STEEL SHIPMENTS, 1950-1969 (thousand net tons)

Years	Scrap Produced	Steel Shipments	Ratio: Scrap Produced to Steel Shipments
1950-1954	160,325	367,470	.44
1955-1959	168,898	377,154	.45
1959-1964	181,924	368,327	.49
1965-1969	232,974	452,291	.52

Source: Annual statistical reports, American Iron and Steel Institute.

The increased generation of home scrap has been caused by numerous factors. While processing equipment has been substantially upgraded over this period to provide better and higher yield products, the quality demands of the marketplace, increasing competition between both domestic and foreign producers, and the changing product mix toward lighter, flat rolled products from heavier sections have required increased quality control measures, resulting in lower yields from raw steel production. For example, in 1950, flat rolled products accounted for slightly over 35 percent of total steel shipments; in 1969, the flat rolled proportion had grown to 47 percent. Production of alloy and stainless steels, with lower product yields than carbon steels, has increased. Standard and line pipe, rails and accessories, plates, and semi-finished (with the exception of the recent export surge) have all shown decreases over this period (Table V-9).

TABLE V-9. PERCENTAGE DISTRIBUTION OF STEEL SHIPMENTS BY PRODUCT GROUP AND GRADE, 1940-1969

Product Group or Grade	1940	1950	1955	1960	1965	1969
Semi-finished	13.3	5.6	5.6	4.0	4.9	6.8
Shapes and Plates	16.5	14.2	14.1	16.0	17.9	15.4
Rails and Accessories	5.4	4.2	2.5	1.8	1.6	1.6
Bars and Tool Steels	16.9	15.7	15.3	14.9	15.6	15.3
Pipe and Tubing	8.6	12.3	11.6	9.9	9.4	9.8
Wire and Wire Products	6.0	6.3	5.1	4.2	3.8	3.5
Tin Mill Products	6.5	6.4	7.6	8.5	7.2	7.0
Sheets and Strip	26.8	31.3	38.2	40.7	39.6	40.6
Grades						
Carbon	N.A.	92.8	92.6	93.0	90.8	90.6
Alloy	N.A.	6.6	6.6	6.2	8.3	8.4
Stainless	0.4	0.6	0.8	0.8	0.9	1.0

Source: Annual statistical reports, American Iron and Steel Institute.

Impact of Emerging Technologies. New technologies have had, and will continue to have, their impact on scrap consumption trends. Continuous casting and direct reduction of ores are among the most prominent today.

Continuous Casting. It is expected that continuous casting will have a beneficial effect on the scrap industry. This process, which eliminates the ingot and blooming/slabbing mill stages of steel production and permits casting direct to the semifinished product, had an estimated 1970 capacity of about 17 million tons, up from less than 1 million tons only 5 years ago. No statistics are available on actual production, but due to the newness of much of the capacity and steel demand factors, production is substantially below capacity operations. Slab casting accounts for about 60 percent of the total, with merchant and special quality bar the remainder. A listing of the major casting installations appears as Table V-10, and a schematic of continuous casting machines appears in Figure V-9.

Significant savings in yield and therefore costs, plus lower capital costs relative to a slabbing mill complex, make continuous casting an attractive investment. At present, continuous casting appears technically feasible for about 80 percent of all steel production. However, it is difficult to estimate the future for continuous casting. Previous optimistic forecasts for its growth have not been achieved. BDSA in 1966 estimated that by 1970, 18.5 percent of all steel would be continuously cast, and 38.5 percent by 1975.(2) "33" Magazine, which has followed the patterns of continuous casting developments closely, estimated in 1968 that by 1972, 40 million tons of capacity would be installed.(3) Among the reasons as to why these optimistic forecasts have not as yet been achieved are: the natural hesitancy in adoption of new processes; significant start-up problems with certain initial casting operations which tended to discourage others until the problems were solved; the lack of a real need for additional semifinished product capacity; and limited industry financial resources. Battelle-Columbus estimates that installed continuous casting capacity will approximate 40 million by 1985, accounting for over 15 percent of raw steel production at that time. Increases beyond that will be governed by the need for capacity increases, the financial resources of the steel industry, and the record of major new casters now going on-stream.

FIGURE V-9. VERTICAL BEND AND CURVED-MOLD CONTINUOUS CASTING MACHINES

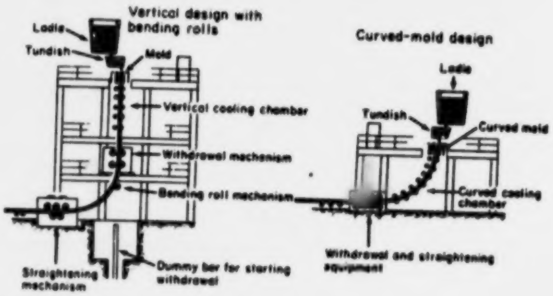

Vertical design with bending rolls
Ladle
Tundish
Mold
Vertical cooling chamber
Withdrawal mechanism
Bending roll mechanism
Straightening mechanism
Dummy bar for starting withdrawal
Curved-mold design
Ladle
Tundish
Curved mold
Curved cooling chamber
Withdrawal and straightening equipment

TABLE V-10. CONTINUOUS CASTING FACILITIES

Company	Location	Type of Machine	Number of Strands	Mold Sizes, inches	Capacity, net tons	Type of Steel Cast	Start-Up Year
			BILLETS AND BLOOMS				
Northeast							
U.S. Steel Corp.	Fairless, Pa.	Vert-Bend	2	n.a.	500,000	C & Low Alloy	1972
New Jersey Steel & Structural Corp.	Tenafly, N.J.	Curved Mold	4	n.a.	n.a.	Carbon	1972
Pittsburgh							
Jones & Laughlin	Aliquippa, Pa.	Vert-Bend	6	4 x 4 to 7 x 7	500,000	C & Low Alloy	1969
Buffalo							
Roblin Industries	Dunkirk, N.Y.	Vert-Bend	2	3 x 3 to 6 x 6	120,000	C & Low Alloy	1964
Youngstown							
Copperweld Steel	Warren, Ohio	Curved Mold	4	5 x 5 to 8 x 8	330,000	C & Low Alloy	1965
Armco Steel	Marion, Ohio	Vert-Bend	3	2 x 2 to 5 x 5	100,000	Carbon	1968
Republic Steel	Canton, Ohio	Vertical	4	8 x 10	800,000	Low Alloy & SS	1968
Timken	Canton, Ohio	Curved Mold	4	9 x 12	300,000	Low Alloy	1969
Detroit							
National Steel	Ecorse, Mich.	Curved Mold	4	7 x 7	800,000	Low Alloy	1969
Chicago							
Calumet Steel	Chicago Hts., Ill.	Vert-Bend	4	3 x 3 to 6 x 6	200,000	Carbon	1968
Inland Steel	Ind. Hbr., Ind.	Curved Mold	4	5 x 5 to 7 x 7	500,000	C & Low Alloy	1971
North Star Steel	St. Paul, Minn.	Vert-Bend	3	4 x 4 to 6 x 8	200,000	Carbon	1967
		Curved Mold	3	7 x 7	160,000	Carbon	1970
U.S. Steel	S. Chicago, Ill.	Vert-Bend	4	7 x 7	800,000	Low Alloy	1970
Wisconsin Steel	Chicago, Ill.	Vertical	8	5 x 5 to 6 x 6	200,000	Low Alloy	1966
Cincinnati							
Kentucky Steel	Coalton, Ky.	Curved Mold	2	4 x 4 to 5 x 7	120,000	Carbon	1970
Southern							
Armco Steel	Sand Springs, Okl.	Curved Mold	6	3 x 3 to 5 x 5	180,000	Carbon	1965
Border Steel	Vinton, Texas	Curved Mold	3	4 x 4 to 5 x 7	120,000	Carbon	1970
Conners Steel	Birmingham, Ala.	Vert-Bend	4	3 x 3 to 6 x 6	200,000	Carbon	1964
E. Carolina Steel	Darlington, S. C.	Curved Mold	2	3 x 3 to 6 x 6	75,000	Carbon	1969
		Curved Mold	2		55,000	Carbon	1971
Florida Steel	Tampa, Fla.	Curved Mold	4	3 x 3 to 5 x 5	200,000	Carbon	1965
	Indian Town, Fla.	Curved Mold	3	4 x 4	90,000	Carbon	1970
Georgetown Steel	Georgetown, S. C.	Curved Mold	4	4 x 5	150,000	Carbon	1969
		Vert-Bend	4	4 x 4 to 6 x 6	150,000	Carbon	1970
Roanoke Steel	Roanoke, Va.	Vertical	2	3 x 3 to 6 x 6	100,000	Carbon	1963
		Curved Mold	2	4 x 4	100,000	Carbon	1971
Tennessee Forge	Harriman, Tenn.	Vertical	2	4 x 4	100,000	Carbon	1966
Knoxville Iron	Knoxville, Tenn.	Curved Mold	2	4 x 4 to 6 x 6	80,000	Carbon	1970
St. Louis							
Keystone S & W	Peoria, Ill.	Vert-Bend	6	3 x 3 to 6 x 6	400,000	Carbon	1968
Laclede Steel	Alton, Ill.	Vert-Bend	6	4 x 4 to 8 x 16	700,000	Carbon	1969
Tennessee Forge	Newport, Ark.	Curved Mold	2	4 x 4 to 4 x 6	100,000	Carbon	1971
Western							
Etiwanda Steel	Etiwanda, Calif.	Curved Mold	2	3 x 3 to 4 x 4	100,000	Carbon	1967
Soule Steel	Long Beach, Calif.	Curved Mold	2	5 x 5	60,000	Carbon	1965
U.S. Steel Corp.	Torrance, Calif.	Vert-Bend	4	3 x 3 to 4 x 13	300,000	Carbon	1968
Cascade Steel Rolling Mills	McMinnville, Oregon	Vert-Bend	2	4 x 4 to 6 x 6	130,000	Carbon	1970
			SLABS				
Northeast							
Lukens Steel	Coatesville, Pa.	Curved Mold	1	7 x 65 to 12 x 85	450,000	Carbon & Low Alloy	1970
Phoenix Steel	Claymont, Del.	Curved Mold	2	6 x 60 to 12 x 80	500,000	Low Alloy	1966
Pittsburgh							
Armco Steel	Butler, Pa.	Curved Mold	2	5 x 26 to 8 x 64	800,000	Alloy & Stainless	1970
Crucible Steel	Midland, Pa.	Curved Mold	2	8 x 25 to 10 x 52	300,000	Alloy & Stainless	1972
National Steel	Weirton, W. Va.	Curved Mold	4	7 x 30 to 11 x 40	1,500,000	Low Carbon	1968
Youngstown							
Republic Steel	Canton, Ohio	Vertical	2	6 x 25 to 5 x 50	1,000,000	Alloy & Stainless	1969
Detroit							
McLouth Steel	Trenton, Mich.	Curved Mold	4	12 x 32 to 12 x 60	2,300,000	Low Carbon	1968
Chicago							
Inland Steel	Indiana Hbr., Ind.	Curved Mold	2	10 x 30 to 10 x 66	1,250,000	Low Carbon	1972
U.S. Steel	Gary, Ind.	Vertical-Bend	1	9 x 55 to 9 x 76	2,100,000	Low Carbon	1967
Cincinnati							
Armco Steel	Middletown, Ohio	Curved Mold	2	7 x 25 to 12 x 82	1,000,000	Low Carbon	1971
Southern							
U.S. Steel Corp.	Houston, Texas	Vertical-Bend	1	9 x 55 to 9 x 76	1,500,000	Carbon & Alloy	1971

Source: Battelle-Columbus Laboratories.

The effect of continuous casting on purchased scrap requirements should be beneficial. As simplified in Table V-11, both total metallic input and home scrap generation are significantly reduced over conventional practice. The net effect, all things equal, could be an increase in purchased scrap consumption by 15 percent for continuously cast steels in terms of the hypothetical industry average charge shown below.

TABLE V-11. PURCHASED SCRAP REQUIREMENT, CONVENTIONAL VERSUS CONTINUOUS CASTING

To Produce 100 tons of Finished Product

	Conventional		Continuous	
Steelmaking furnace charge		Tons		Tons
Hot Metal		82		71
Scrap		75		65
Home	43		28	
Purchased	32		37	
Total		157		136
Ingot		142		
Semifinished (slabs, billets)		118		118
Finished Product		100		100
Yield Losses				
Recoverable, i.e., home scrap (crop ends, rejects, etc.)		43		28
Nonrecoverable losses (scale, scarfing and grinding losses, oxidation, etc.)		14		8
Total		57		36

Assumptions:

(1) Furnace charge: 48 percent scrap, 52 percent pig iron.
(2) Yields: conventional - ingot from charge, 90 percent; semifinished from ingot, 83 percent; finished from semifinished, 85 percent.
continuous - semifinished from charge, 87 percent; finished from semifinished, 85 percent.
(3) Semifinished: 70 percent slabs, 30 percent billets/bars.

Source: Battelle-Columbus Estimates.

However, there will also be less hot metal required per ton of finished product, therefore making more available as a substitute for scrap. For example, in the illustration shown, hot metal requirements will be 9 tons less. If the producer requires only half of the savings for capacity increases, he could increase his hot metal charge to 56 percent from 52 percent. Purchased scrap requirements would them be reduced to 32 tons, or no gain in purchases. The steelmaker will make his decision based on economic operating practice and quality considerations. He will use the most economic raw material available. The scrap industry can influence that choice by providing increased low-cost quality products.

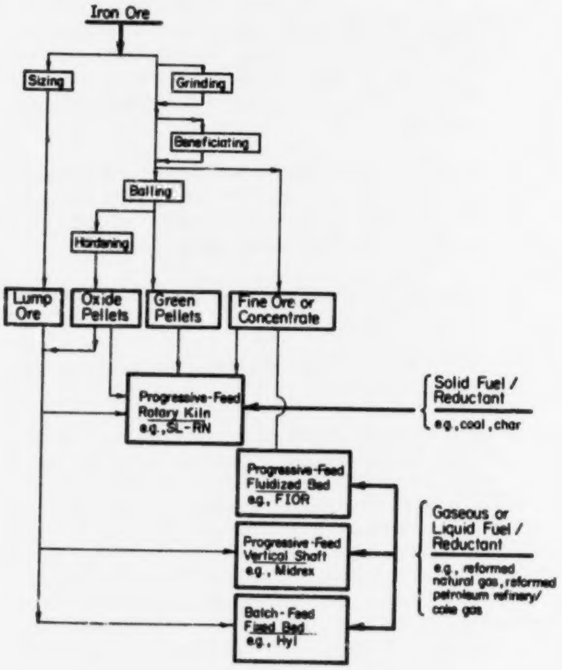
Direct Reduction. A significant threat to the scrap industry is presented by direct reduced material, i.e., iron ore reduced, at least partially, to metal by means other than the blast furnace. Basically, the process involves the reduction of iron ore pellets with an iron content of 65 percent, by solid or gaseous reducers to produce pellets, briquetts, or liquid iron having an iron content up to 95 percent. This material is then fed to the steelmaking furnace as a substitute/complement to blast furnace hot metal, pig iron, or scrap, or used as a blast furnace feed. A number of processes exist as seen in Table V-12 below. The materials are known by various names, including "reduced pellets," "sponge iron," and "metallized ores." A simplified flow chart of direct reduction processes appear as Figure V-10.

TABLE V-12. MAJOR DIRECT REDUCTION PROCESSES

Process	Type	Fuel	Approx. Fuel Consumption, 100,000 Btu per ton of Fe	Product State	Degree of Reduction, pct
SL-RN	Rotary Kiln	Solid Fuel	135–160	Sized Lumps or Pellets	96.8
Krupp-Renn	Rotary Kiln	Solid Fuel/ Gas	220–300	Iron Nodules	90–97
Strategic-Udy	Rotary Kiln	Solid Fuel/ Electricity	170	Liquid Iron	—
HyL	Static Bed	Gaseous Reduction	185–240	Sized Lumps or Pellets	83.9
ESSO-FIOR	Fluidised Bed	Gaseous Reduction	No Information	Briquettes	92.5
Nu-Iron	Fluidised Bed	Gaseous Reduction	140	Briquettes	75
Purofer	Shaft Furnace	Gaseous Reduction	130	Sized Lumps or Pellets	Up to 95
Midrex	Shaft Furnace	Gaseous Reduction	70	Sized Lumps or Pellets	Up to 95
Armco	Shaft Furnace	Gaseous Reduction	110	Pellets	92

Source: "Iron Age," August 27, 1970, p 75.

FIGURE V-10. NATURE OF DIRECT REDUCTION PROCESSES AND CLASSIFICATION OF TYPES OF PROCESSES


Iron Ore
Sizing
Grinding
Beneficiating
Balling
Hardening
Lump Ore
Oxide Pellets
Green Pellets
Fine Ore or Concentrate
Progressive-Feed Rotary Kiln e.g., SL-RN
Solid Fuel / Reductant
e.g., coal, char
Progressive-Feed Fluidized Bed e.g., FIOR
Progressive-Feed Vertical Shaft e.g., Midrex
Batch-Feed Fixed Bed e.g., Hyl
Gaseous or Liquid Fuel / Reductant
e.g., reformed natural gas, reformed petroleum refinery/ coke gas

The major claims for using direct-reduced materials rather than scrap include: (1) form that permits controlled charging, (2) porous and uniform structure which makes for rapid melting, and (3) known chemistry which simplifies and speeds refining. Thus, the uniform physical and chemical nature of direct-reduced materials permits reliable prediction of the thermal and chemical finishing conditions, providing for adjustments as required during charging.

The major use of direct-reduced materials has centered around the electric furnace. By combining the use of metallized pellets or briquettes with continuous charging to the furnace, heat times have been shortened and furnace productivity increased. The results from one series of tests indicating this are shown in Table V-13..

TABLE V-13. **Average Melt Cycle Time and Productivity Rates**

Charge-Tap Cycle (excluding delays)	All-Scrap	Pellets			Briquettes
		19%	23%	40%	10.5%
Time, hrs.	3.78	2.95	2.85	3.16	3.26
% Decrease	Base	22.0	24.6	16.4	13.8
Productivity, tons/hr.	41.43	52.41	54.10	49.59	48.41
% Increase	Base	26.5	30.6	29.7	16.8
Charge-Charge Cycle (including delays & fettling)					
Time, hrs.	4.62	3.80	3.89	4.32	3.96
% Decrease	Base	17.7	15.8	6.5	14.3
Productivity, tons/hr.	33.90	40.68	39.64	36.27	39.85
% Increase	Base	20.0	16.9	7.0	17.6
Fettling & Delays, hr.	0.83	0.85	1.04	1.16	0.70
Feed Time, hrs.	—	0.38	0.49	0.79	0.33
Number of Heats	200	4	44	8	108

Source: Blast Furnace and Steel Plant, 58(10):738, Oct. 1970.

Part of the beneficial effects is attributable to continuous charging, which is facilitated by using pellets or briquettes instead of the usual grades of scrap. At present, the technological advantages of using direct-reduced materials in electric steelmaking furnaces are evolving slowly. One of the deterrents is that large amounts of direct-reduced materials are not available on the open market to support widespread testing and evaluation. Also, the results reported to date have not shown a clear superiority of direct-reduced pellets and briquettes over conventional practices using scrap. For these reasons, and because of the uncertainty about the eventual price of reduced pellets and briquettes, acceptance is proceeding slowly in an evolutionary manner, rather than as a technical revolution.

The economics of usage are uncertain at present and are difficult to develop, as a future cost of both scrap and pre-reduced materials are difficult to predict. However, as shown in Tables V-14 and V-15 below and using the relative yield and price factors indicated, the cost of the charge using direct reduced materials in combination with scrap are competitive with an all scrap charge.

TABLE V-14. COMPARISON OF VARIOUS CHARGE MATERIALS

	Relative Yield Factor	Relative Price	Copper Content, %	Sulfur Content, %
Prereduced Materials	1.00	1.20	.02	.020
No. 1 Dealer Bundles	1.00	1.15	.10	.020
No. 1 Heavy Melting	1.00	1.00	.20	.030
No. 2 Heavy Melting	0.90	0.80	.35	.045
S. S. Turnings	0.92	0.70	.20	.07

Source: Blast Furnace and Steel Plant, 58(10):743, Oct. 1970.

TABLE V-15. RELATIVE CHARGE BALANCE AND ECONOMICS

	All-scrap Charge		Scrap & Prereduced Iron	
	Percentage	Relative Cost*	Percentage	Relative Cost*
Prereduced Material	—	—	10.9	.131
No. 1 Dealer Bundles	0.6	.007	—	—
No. 1 Heavy Melting	94.4	.944	75.6	.756
No. 2 Heavy Melting	—	—	11.2	.090
S. S. Turnings	5.0	.035	2.3	.016
	100.0	.986	100.00	.993

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*Cost relative to No. 1 Heavy Melting Scrap

Source: Blast Furnace and Steel Plant, 58(10):743, Oct. 1970.

Use of direct-reduced materials in the blast furnace has received attention mainly on a pilot-plant and limited commercial scale. However, there is little question that such use will lower coke rates and increase the productivity of blast furnaces. Whether these desirable effects will result in lower overall cost of making hot metal depends on the cost of the direct-reduced materials. Therefore, blast furnace usage poses an indirect threat to scrap consumption through potential lower hot metal costs competing with scrap as charge materials to the steelmaking furnaces.

Historically, interest in direct reduction has risen and fallen with the price of scrap, as well as its availability and that of hot metal. In an environment where the price of good quality steel scrap was fairly stable at about $30 per ton, little risk capital was available to develop and commercialize direct reduction processes. During the period 1958 through mid-1969, a degree of scrap price stability had been achieved. However, beginning in late 1969, scrap prices soared, suggesting that price stability in scrap was a goal yet to be achieved.

In addition to use as a hedge against scrap price fluctuations, direct reduction provides iron at a fraction of the capital cost of a blast furnace complex. It is expected that most capacity additions will be of an incremental nature as opposed to complete new integrated facilities, i.e., direct reduction and electric furnaces versus coke ovens, blast furnace, and basic oxygen furnaces. Further, its mobility of location is another advantage, i.e., mines, mills, or central location versus blast furnace at the mill.

Direct reduction has been on the horizon since the 1950's, but today it is becoming a reality. The current domestic outlook appears in Table V-16.

TABLE V-16. PRESENT AND PLANNED DIRECT REDUCTION CAPACITY TO SUPPLY U.S. CONSUMERS

Company	Location	Annual Capacity (net tons)	Completion Date	Supplies
Midrex Division, Midland Ross Corporation	Oregon	400,000	1969	Oregon Steel electric furnaces
	South Carolina	400,000	1971	Georgetown Steel electric furnaces
	Louisiana	800,000	1972-73	U.S. markets--steelworks and foundries
U.S. Steel Corporation	Venezuela	1,100,000	1972-73	Fairless and Texas Works
Armco Steel	Texas	400,000	1971-72	Houston Works electric furnaces

It is difficult to assess the future for direct reduction. The next few years will be critical, as the results come in from the plants under construction and recently started. If these plants produce at their rated capacities and meet the forecasts made for them in terms of energy required, capital and operating costs, and product quality, then direct reduction will be established as a viable commercial procedure. This experience, hot metal and scrap availability, and scrap prices will determine the degree of threat that direct reduction presents to the scrap industry. As with continuous casting, the scrap industry can influence the threat posed by providing increased low-cost quality products.

The Iron and Steel Castings Industries

The second largest market for iron and steel scrap is the foundry industry. In 1970, 20 percent of total domestic scrap consumption was in foundries.

The iron and steel castings industries, composed of gray iron, malleable iron, and steel foundries, had sales in 1970 of $4.8 billion, ranking it 17th among all American industries. It employs 230,000 people making it the 9th largest industry in terms of employment. There are approximately 2,000 foundries, with major producing areas in the Middle Atlantic and East North Central states. Many are small local foundries; approximately one-third of the firms employ less than 20 employees.

There are three basic segments of the foundry industry, according to end product. Gray iron castings dominate, accounting for 84 percent of total castings shipments and 64 percent of sales in 1970. Second is steel castings, with 10 percent and 27 percent respectively of shipments and sales, followed by malleable iron castings with the remaining 6 percent of shipments and 9 percent of sales. Iron and Steel castings shipments totalled 16.5 million tons in 1970 (Table V-17).

TABLE V-17. FERROUS CASTINGS SHIPMENTS, 1960-1970.

Year	Total	Gray Iron	Malleable Iron	Steel Castings	Ductile(1) Iron
			Thousand Net Tons		
1960	13,807	11,394	821	1,392	170
1961	12,764	10,824	723	1,217	175
1962	13,844	11,553	868	1,423	254
1963	15,201	12,764	933	1,504	373
1964	17,152	14,316	1,001	1,835	478
1965	18,810	15,713	1,136	1,961	585
1966	19,004	15,716	1,132	2,156	785
1967	17,225	14,328	1,040	1,857	863
1968	17,858	15,034	1,094	1,730	957
1969	18,984	15,935	1,149	1,900	1,285
1970	16,529	13,954	852	1,723	1,608
			Percent of Total		
1960	100.0	84.0	5.9	10.1	1.2
1961	100.0	84.8	5.7	9.5	1.4
1962	100.0	83.5	6.3	10.3	1.8
1963	100.0	84.0	6.1	9.9	2.5
1964	100.0	83.5	5.8	10.7	2.8
1965	100.0	83.5	6.0	10.4	3.1
1966	100.0	83.7	6.0	11.3	4.1
1967	100.0	83.2	6.0	10.8	5.0
1968	100.0	84.2	6.1	9.7	5.4
1969	100.0	83.9	6.1	10.0	6.8
1970	100.0	84.4	5.2	10.4	9.7

(1) Included with gray iron.

Source: U.S. Bureau of Census.

Structure

Many plants produce more than one type of metal casting. It is, therefore, difficult to separate these plants into categories by type. A general approximation indicates there are about 1,600 gray iron foundries, about 75 malleable iron foundries, and about 375 steel foundries. This includes both independent or jobbing foundries, and captive foundries, those that produce castings primarily for their own use. In the latter category are foundries operated by the major automotive firms, such as General Motors, Ford, and Chrysler; major farm machinery companies, such as Allis-Chalmers, Deere, and International Harvester; major heating and plumbing fixtures companies, such as American Standard and Crane; and major steel producers, such as U.S. Steel, Bethlehem, and Republic. Captive foundries are estimated at about 20 percent in number of total foundries, but over 40 percent of all tonnage. The major exception to the "for own use" classification is with steel castings; close to 80 percent are produced for sale, although a minor amount of the tonnage is produced by firms whose primary business is in the basic steel industry.

As previously noted, gray iron is the predominant ferrous casting product. It is estimated that 11 companies, with about 60 foundries, account for approximately 70 percent of total gray iron production. These major producers are listed in Table V-18.

TABLE V-18. MAJOR PRODUCERS OF GRAY IRON CASTINGS ESTIMATED FOR 1969

Automotive Shops		Production (thousand net tons)
Ford Motor Company		
Dearborn, Michigan		720
Dearborn, Michigan		240
Brook Park, Ohio		720
Windsor Ontario		240
Fairfield, Iowa		12
Total		1,932
General Motors Corporation		
Danville, Illinois	Central Foundry Division	240
Defiance, Ohio	Central Foundry Division	336
Saginaw, Michigan	Central Foundry Division	336
Anderson, Indiana	(Delco Division)	120
Saginaw, Michigan	Chevrolet Division	360
Saginaw, Michigan	Chevrolet Division	960
Tonawanda, New York	Chevrolet Division	600
Pontiac, Michigan	(Pontiac Division)	312
Flint, Michigan	(Buick Division)	312
St. Catherine, Ontario	(McKinnom Division)	240
Total		3,816
Chrysler Corporation		
Detroit, Michigan		144
Detroit, Michigan		192
Indianapolis, Indiana		192
Total		528
Total Automotive Shops		6,276
Pipe Shops (Some Including Miscellaneous Castings)		
American Cast Iron Pipe Company		
Birmingham, Alabama		768
Total		768
U.S. Pipe and Foundry Company		
Birmingham, Alabama		192
Burlington, New York		192
Union City, California		192
Chattanooga, Tennessee		144
Orange, New Jersey		24
Anniston, Alabama		72
Bessemer, Alabama		192
Total		1,008
McWane Cast Iron Pipe Company		
Birmingham, Alabama		240
Provo, Utah		144
Total		384
Woodward Company, Division of The Mead Corporation		
Anniston, Alabama		480
South Gate, California		24
Tyler, Texas		192
Columbus, Indiana		72
Lynchburg, Virginia		192
Radford, Virginia		192
Total		1,152
Central Foundry Company		
Holt, Alabama		144
Buffalo, New York		120
Quakertown, Pennsylvania		24
Total		288
Total Pipe Shops		3,680

Large Miscellaneous Shops	
Dayton Malleable Iron Company	
Ironton, Ohio	120
Columbus, Ohio	96
Dayton, Ohio	144
Total	360
Textron, Inc.	
Sidney, Ohio	24
Muskegon, Michigan	96
Muskegon, Michigan	60
Muskegon, Michigan	120
South Haven, Michigan	60
Total	360
Abex Corporation	
Pamona, California	72
Denver, Colorado	48
Chicago, Illinois	72
Baltimore, Maryland	48
Minneapolis, Minnesota	36
Kansas City, Missouri	24
Buffalo, New York	36
Meadow Lands, Pennsylvania	36
Chattanooga, Tennessee	36
Houston, Texas	36
Total	444
Large Miscellaneous Total	1,164
Total Production by Eleven Major Companies	11,120
Other Independent Foundries' Production	4,815
TOTAL PRODUCTION GRAY IRON, 1969	15,935

Source: Cleveland, Gray and Ductile Iron Founders' Society, Inc.

A further indication of the relative stratification of the gray iron industry can be seen from a comparison of sales and volume. As shown in Table V-19, approximately 60 percent of all foundries have sales under $1 million; over 90 percent have less than $10 million in sales.

TABLE V-19. GRAY IRON FOUNDRIES

Group by Size (1967 Value of Gray Iron Shipments)	Number	Percent
Total respondent foundries	1,376	100.0
Under $500,000	604	43.9
$500,000 to $999,999	240	17.4
$1,000,000 to $2,499,999	247	18.0
$2,500,000 to $9,999,999	179	13.0
$10,000,000 and over	37	2.7
Value not reported	69	5.0

Source: National Air Pollution Control Administration. Economic impact of air pollution controls on gray iron foundry industry. Publication AP-74. Washington, U.S. Government Printing Office, Nov. 1970. p.78.

The geographic distribution of castings production is wide-spread throughout the United States, but has heavy concentration in the Middle Atlantic and East North Central States as shown in Figure V-11 and Table V-20. These two divisions account for 70 percent of all production; with the addition of Alabama, the total climbs to almost 80 percent.

FIGURE V-11. IRON AND STEEL CASTINGS SHIPMENTS BY MAJOR STATES, 1969

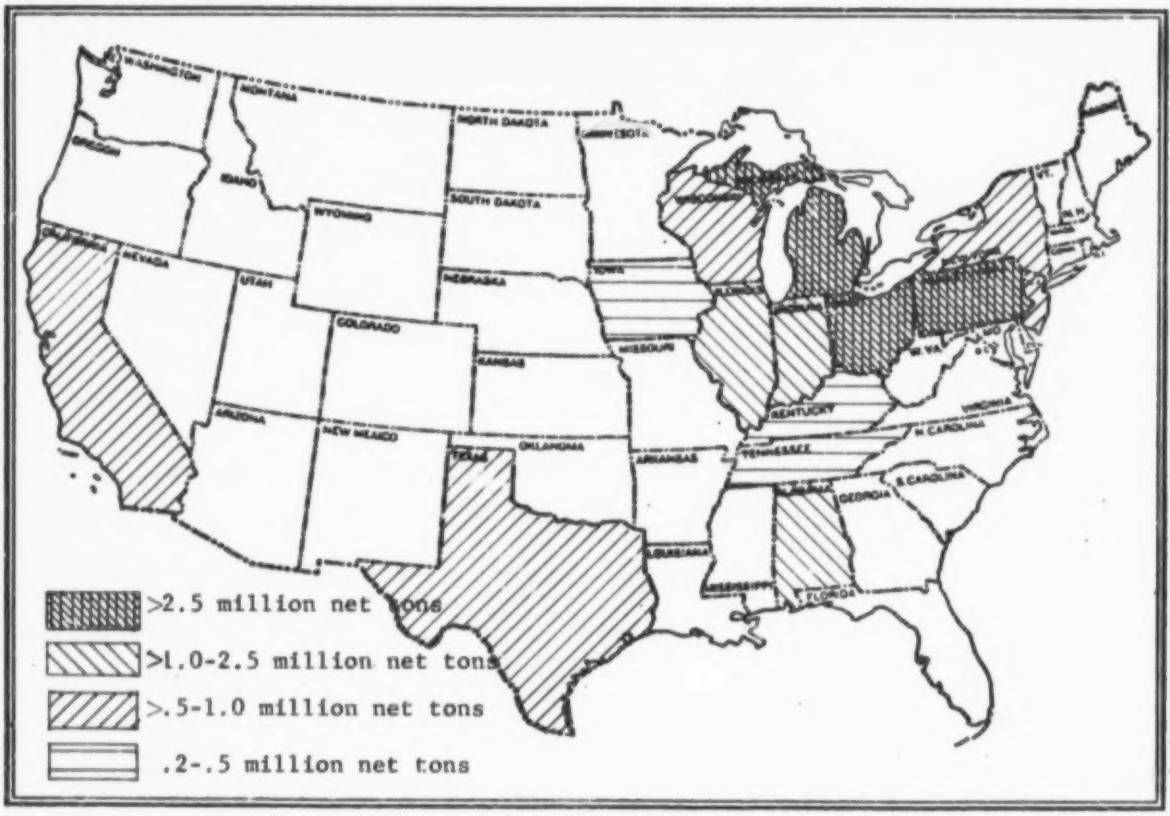
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
KENTUCKY
TENNESSEE
MISSISSIPPI
FLORIDA
GEORGIA
S.CAROLINA
N.CAROLINA
VIRGINIA
W.VA
VT.
N.H.
>2.5 million net tons
>1.0-2.5 million net tons
>.5-1.0 million net tons
.2-.5 million net tons

TABLE V-20. SHIPMENTS OF IRON AND STEEL CASTINGS BY GEOGRAPHIC DIVISION AND MAJOR STATES, 1969
(percent)

	Total	Gray Iron	Malleable Iron	Steel
Division				
New England	1.3	1.3	2.3	(D)
Middle Atlantic	21.3	22.4	6.7	20.8
East North Central	48.7	47.2	79.5	42.0
West North Central	4.3	3.8	1.3	10.2
South Atlantic	2.7	2.9	(D)	2.2
East South Central	12.3	14.2	(D)	4.0
West South Central	3.7	3.3	(D)	9.4
Mountain	1.3	1.6	(D)	(D)
Pacific	3.3	3.2	(D)	6.6
Major States				
Michigan	16.0	16.5	30.6	3.0
Pennsylvania	14.3	14.8	5.1(e)	15.6
Ohio	13.5	13.3	20.5	12.9
Alabama	9.6	11.1	(d)	3.5(e)
Illinois	9.6	8.4	19.0	14.1
Indiana	5.6	5.9	3.8	4.5
Wisconsin	3.9	3.4	5.5	7.4
Texas	3.3	3.1	(D)	6.5(e)
California	2.9	3.1	--	3.5

(D) Withheld to prevent disclosure
(e) estimated
Source: Based on Bureau of Census and Bureau of Mines, Current Industrial Reports M33A - (69)-B.

Growth

Shipments of castings follow closely trends in steel shipments. Compared to shipments, the trend has shown a slight increase; however, when compared to steel consumption (shipments plus imports minus exports), the rate of growth has shown a slight decrease over that of steel (Table V-21). The import-export balance in castings is negligible, with an export balance of slightly over 1 percent of shipments in 1970.

TABLE V-21. CASTINGS SHIPMENTS (Percent)

	Steel Shipments	Steel Consumption
1960	19.4%	19.3%
1961	19.3	19.0
1962	19.6	19.0
1963	20.1	19.3
1964	20.2	19.6
1965	20.3	18.7
1966	21.1	19.2
1967	20.5	18.4
1968	19.4	16.6
1969	20.2	18.5
1970	18.2	17.0

Shipments of iron and steel castings are heavily concentrated in growth areas of transportation and construction. Market distribution of castings shipments is shown in Table V-22.

TABLE V-22. MARKETS FOR FERROUS CASTINGS

Gray and Ductile Iron Castings	Percent
Ingot molds	21.7
Construction castings	20.4
Motor vehicles and parts	19.7
Farm machinery	5.6
Valves	2.1
Construction machinery	1.9
Internal combustion engine, excluding automotive	1.9
Pumps and compressors	1.8
Pressure pipe and fittings	1.4
Machine tools	1.3
Enameled sanitary ware	1.3
Heating equipment	1.3
All other	19.6

Source: U.S. Department of Commerce, Business and Defense Administration, Metals Consumed in Manufacturing and Construction, 1969.

Malleable Iron Castings	
Motor vehicles and parts	69
Electrical equipment and machinery	3
Construction and mining machinery and equipment	5
Other machinery	7
Ordnance	4
Railroad	2
Agricultural	2
All other	8

Source: Malleable Founders Society, based on 1970 data.

Steel Castings	
Railroad equipment	45.8
Construction	14.4
Motor vehicles and parts	7.9
Mining and crushing machinery	6.3
Oil and gas field valves and piping	5.2
Rolling mills	4.8
Special machinery, products, and components	3.7
Electrical machinery and equipment	2.9
All other	9.0

Source: Rocky River, Ohio, Steel Founders' Society of America, based on 1969 data.

While ferrous casting shipments have shown an increase over the past two decades, from 16 million tons in 1950 to 19 million tons in 1970, there has been a significant contraction in the number of foundries. In gray iron alone, the number has shrunk almost 50 percent, from 1950's 3,000 to 1,600 in 1969. More recent trends indicate a slowing down in attrition, but certain states, noticeably Pennsylvania and Michigan, have been particularly hard hit. The geographic distribution of iron and steel foundries by state and type is shown in Table V-23 for recent years.

Much of the growth has come from captive and larger foundries at the expense of the smaller and less efficient ones. In 1950, the average gray iron foundry shipped 4,500 tons annually; by 1969, this had more than doubled to 10,000 tons. A relative measure of foundry size is shown by Table V-24, indicating plant size measured by number of employees. In a macro sense, this appears healthy; contrary to popular opinion that a shrinking foundry population and captive increases tend to remove product from sale on the open market, the actual percentage of total shipments for sale, as compared to for own use, has increased over the last twenty years to about 60 percent in 1970, compared to 55 percent in 1950.

TABLE V-23. GEOGRAPHICAL DISTRIBUTION OF IRON AND STEEL FOUNDRIES

State	Gray Iron				Ductile Iron				Malleable				Steel			
	1969	1967	1965	1963	1969	1967	1965	1963	1969	1967	1965	1963	1969	1967	1965	1963
Alabama	56	56	59	65	17	16	17	12	2	3	2	2	14	12	12	11
Alaska	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arizona	4	3	3	4	1	--	--	--	--	--	--	--	4	3	2	2
Arkansas	10	11	10	10	1	1	1	1	--	--	--	--	1	1	1	1
California	88	86	95	102	29	23	24	23	1	1	1	4	53	48	50	49
Colorado	15	17	18	20	4	3	4	3	--	--	--	1	7	6	4	5
Connecticut	24	23	24	29	7	6	6	5	4	5	5	5	14	11	10	10
Delaware	1	2	2	2	--	--	--	--	--	--	--	--	2	2	2	2
District of Columbia	--	--	1	1	--	--	1	1	--	--	--	--	--	--	1	1
Florida	17	19	19	20	3	3	2	2	--	--	--	--	10	8	7	6
Georgia	32	29	32	35	8	6	6	7	--	--	--	--	5	5	4	4
Hawaii	3	4	3	3	--	--	--	--	--	--	--	--	1	1	1	1
Idaho	4	4	4	4	1	1	1	1	--	--	--	--	--	--	--	1
Illinois	97	104	107	113	32	31	29	28	9	10	11	11	32	33	33	33
Indiana	75	81	75	84	16	12	12	11	4	4	4	5	20	15	15	14
Iowa	36	37	38	43	8	6	5	5	1	2	1	2	3	3	3	3
Kansas	24	22	22	23	9	6	7	7	--	--	--	--	3	4	3	3
Kentucky	11	15	16	16	2	1	--	--	--	--	--	--	1	1	1	1
Louisiana	10	10	16	13	2	2	2	1	--	--	--	--	6	6	6	6
Maine	8	8	8	9	1	--	--	--	--	--	--	--	--	--	--	--
Maryland	13	12	13	14	5	3	2	2	1	1	1	1	4	5	3	4
Massachusetts	53	56	57	67	13	9	9	7	3	3	5	3	10	13	14	15
Michigan	114	122	127	133	36	32	28	28	7	8	6	6	37	38	34	34
Minnesota	36	35	35	38	8	5	4	3	2	1	1	1	9	7	6	6
Mississippi	7	7	8	8	--	--	--	--	--	--	--	1	--	--	--	--
Missouri	28	30	29	33	6	5	3	4	--	--	1	2	17	16	16	13
Montana	2	2	2	4	--	--	--	--	--	--	--	--	--	--	--	--
Nebraska	7	8	8	8	1	--	--	--	--	--	--	--	1	1	1	1
Nevada	1	1	1	1	--	--	--	--	--	--	--	--	1	1	1	--
New Hampshire	8	5	4	8	2	1	--	--	1	1	1	1	7	5	5	3
New Jersey	45	44	48	56	12	10	10	9	2	1	1	2	20	16	17	16
New Mexico	--	1	2	1	--	--	--	--	--	--	--	--	--	--	--	--
New York	82	88	97	103	17	16	19	17	9	7	10	7	26	25	28	31
North Carolina	30	33	36	41	7	5	4	6	--	--	--	--	2	1	1	1
North Dakota	3	2	2	2	--	--	--	--	--	--	--	--	1	--	--	--
Ohio	151	162	159	163	61	52	46	46	16	18	16	18	45	45	43	42
Oklahoma	17	14	14	17	12	6	6	5	--	--	--	--	4	3	2	3
Oregon	13	16	17	16	5	7	7	6	--	--	--	1	12	10	10	10
Pennsylvania	155	183	189	198	48	43	41	34	16	14	13	14	61	61	62	61
Rhode Island	8	9	9	10	2	1	1	2	1	1	1	1	1	1	--	--
South Carolina	15	16	15	17	4	5	5	2	--	--	--	--	3	3	4	1
South Dakota	1	2	2	3	--	--	--	--	--	--	--	--	--	--	--	--
Tennessee	41	45	48	52	7	8	7	5	1	--	--	--	3	3	2	2
Texas	56	63	61	68	18	17	11	8	1	1	1	2	25	19	16	15
Utah	11	9	10	10	5	4	5	5	--	--	1	--	4	3	4	2
Vermont	8	8	10	10	1	--	--	--	--	--	--	1	--	1	1	1
Virginia	33	34	37	37	7	5	5	3	--	--	--	--	5	4	4	4
Washington	21	21	23	23	8	7	6	5	1	1	1	1	17	15	18	18
West Virginia	12	12	12	13	5	4	2	2	1	1	1	1	3	2	2	2
Wisconsin	84	82	85	87	28	25	23	22	10	10	11	11	30	30	27	25
Wyoming	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL UNITED STATES	1,571	1,653	1,712	1,837	459	387	361	328	93	93	95	104	526	487	476	463

Source: Foundry Magazine, Census of Foundries.

TABLE V-24. NUMBER OF PLANTS BY SIZE AND PRINCIPAL METAL CAST, UNITED STATES AND CANADA*

Number of Employees	Gray and Ductile Iron			Malleable			Steel			Total		
	1969	1967	1965	1969	1967	1965	1969	1967	1965	1969	1967	1965
Over 1,000	30	29	22	3	5	4	8	9	7	41	43	33
500-999	30	42	33	13	15	9	25	33	28	68	90	70
250-499	97	93	73	20	20	23	53	56	50	170	169	146
100-249	287	290	272	32	31	35	113	106	98	432	427	405
50-99	371	411	388	8	8	10	72	59	62	464	491	578
20-49	425	428	465	--	1	2	80	70	65	505	499	532
Under 20	398	431	518	1	--	--	65	60	60	451	478	460
TOTAL	1,638	1,724	1,771	77	80	83	416	393	370	2,131	2,197	2,224

* Plants producing more than one type of metal are listed only under principal metal cast.

Source: Foundry Magazine, Census of Foundries.

Casting Technology

The cupola is the basic ironmaking furnace for the iron casting industry today. It is estimated that approximately 90 percent of all gray iron is produced in cupola furnaces, although a significant amount of ductile and malleable iron is produced in electric furnaces. Steel castings are produced primarily in electric furnaces, with 95 percent of the furnaces and 70 percent of the tonnage; open hearth furnaces produce most of the remainder.* It is expected that continued inroads on the cupola will be made by the electric furnace, primarily due to the additional control of metal analysis that can be obtained and increasingly stringent air-pollution control requirements. However, it is generally agreed that within the next decade, the electric furnace proportion will not increase beyond 15 percent. Geographic distribution of foundry melting furnaces is shown in Table V-25.

TABLE V-25. GRAY IRON FOUNDRY MELTING FURNACES, NUMBER OF FOUNDRIES BY TYPE

Geographic Division	Cupola	Electric(1)	Other	Total
New England	87	4	4	95
Middle Atlantic	229	15	3	247
East North Central	428	37	7	472
West North Central	115	4	2	121
South Atlantic	121	9	1	131
East South Central	100	7	1	108
West South Central	62	7	4	73
Mountain	18	8	1	27
Pacific	72	24	6	102
Total	1,232	115	29	1,376
Percent	89.5	8.4	2.1	100.0

(1) Arc and induction, of which induction is 63 percent.

Source: U.S. Department of Health, Education and Welfare, Economic Impact of Air Pollution Controls on Gray Iron Foundry Industry, Nov., 1970, p 79.

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*Based on a survey of 100 foundries, completed in 1968, and appearing in American Society of Metals Metals Handbook, Volume 5, 1970, p 380.

Electric furnaces use basically a 100 percent scrap charge, and obviously offer little opportunity to increase their scrap consumption, other than through increased use of electric furnaces to produce iron and steel castings above current proportions. Therefore, increased usage of scrap in the foundry industry will be governed by either greater replacement of cupola furnaces by electrics, or through increasing the scrap proportion of the cupola charge. Consumption of scrap by type of foundry furnace is shown in Table V-26.

TABLE V-26. FOUNDRY FURNACE CONSUMPTION OF SCRAP AND PIG IRON, 1969

(Thousand Net Tons)

	Iron Foundries		Steel Foundries		Total	
Furnace Type	Scrap	Pig Iron	Scrap	Pig Iron	Scrap	Pig Iron
Open-hearth	--	--	454	50	454	50
Electric	1,767	77	2,466	42	4,233	119
Cupola	12,782	2,751	365	6	13,147	2,757
Other	284	75	58	14	342	89
TOTAL	14,833	2,903	3,342	113	18,175	3,016

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1969. p.609.

As previously noted, some increase in electric furnace production is already taking place; but significant replacement is not anticipated. In the latter, however, scrap is indeed increasing its relative share of the metallic charge to cupolas. Only 10 years ago, the scrap input averaged slightly over 70 percent of total metallics; by 1970, 85 percent was approached. This increase is taking place because of improved melting practices favoring lower price scrap at the expense of pig iron, improved scrap products such as shredded scrap offering a more uniform and higher yield melt, the trend toward higher strength castings which generally require steel scrap for improved strength, and increased melting by water cooled hot blast cupolas which permit higher scrap charges. The increasing scrap proportion of cupola charges is shown in Table V-27.

TABLE V-27. CUPOLA FURNACES SCRAP PERCENT METALLICS

Year	Percent
1960	72.4
1961	73.5
1962	75.9
1963	76.8
1964	78.4
1965	79.7
1966	80.6
1967	81.4
1968	83.6
1969	83.7

Note: A small proportion of cupola output, included ablve is used for hot metal for steel furnaces, which may slightly distort the above comparison.

Source: Derived from Yearbook, Institute of Scrap Iron and Steel, 1970. p.36.

There are a number of factors which make foundries an increasingly desirable market for iron and steel scrap. They include:

(1) Growth rate in excess of steel production, the other major consuming market;

(2) Geographic dispersion enabling more localized usage of scrap, by comparison with limited steel production distribution;

(3) Increasingly greater use of scrap as a percent of the ferrous charge in the basic foundry melting facility, the cupola furnace.

(4) Trend toward replacement of cupola facilities with electric furnaces, using an even greater scrap proportion of the charge, nominally 100 percent.

In order for the scrap industry to capitalize on these factors, the following is required:

(1) Increased cleanliness of scrap charge. The foundry industry, particularly the smaller ones using cupola melting, are faced with air pollution standards difficult to meet. A recent study indicated that only 15 percent of foundries were equipped with furnace air pollution controls.(4) These foundries however represented 40 percent of total production. While the percentage of foundries with controls has increased since 1967, air pollution is still a very serious problem, particularly where the cost of control equipment far exceeds the foundry's ability to pay. As a result, more small foundries are closing their doors, rather than pay the price. Therefore, the greater the cleanliness of the incoming scrap with regard to dirt, oil and grease, and other foreign elements, the greater could be the use of scrap. By comparison, scrap's chief competitor, merchant pig iron acts as a dust emission reductant and is "clean." Briquetting of chips, turnings, and borings also improve this situation.

(2) Increased technological input by the scrap industry on the proper selection of scrap type for the foundry's benefit. In general, the small independent foundry operates on a "past practice" basis, i.e., same charge materials and melting practices today as in the past. With the improvement in scrap products available, and increased melting technology, it may be possible to take advantage of these two factors alone to increase the scrap proportion by its further substitution for pig iron, resulting in better, lower cost castings. Many foundries, hampered by "past practice" and lack

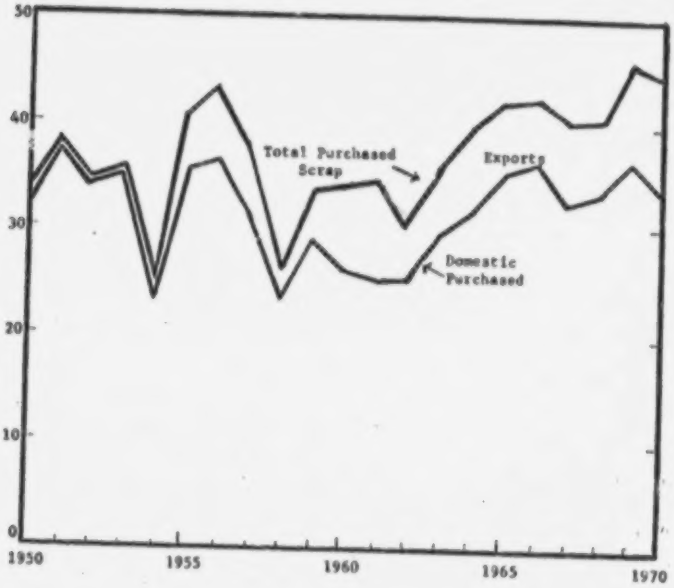
of qualified technical personnel, would welcome this technical assistance from the scrap industry.

(3) Development of an economical "specification ingot". The cupola is a very flexible melting facility which, within limits, can adjust its melt practice, dependent on known analysis of incoming scrap. Obsolete scrap is a heterogeneous material in its presently supplied form, with chemistry variations from lot to lot. If this scrap were melted to a known analysis, density, size, etc., increased utilization would undoubtedly take place. Adjustment of pig iron composition used in combination with the "ingot" should also be possible. It has been estimated that a cost reduction of $10-15 per ton over merchant pig would make this an attractive feed material. Such a product is available from certain stainless and alloy steel scrap, but efforts to develop carbon steel scrap "pigs" in the past have generally failed due to economics. However, with today's technological advances in scrap processing and collection, availability of low-cost obsolete scrap, melting practices, and increasing costs of merchant pig iron, the economics and market potential of this product should undergo a new evaluation in detail through to finished casting.

Export Markets

A major market for iron and steel scrap is foreign producers of iron and steel. In 1970, 10.6 million tons were exported, accounting for 23.8 percent of total purchased scrap. Imports, mainly from Canada, are minor, averaging 300,000 tons per year. The importance of exports to the scrap industry can be seen from Figure V-12. Little significant growth has been made in domestic

FIGURE V-12. TOTAL PURCHASED SCRAP, 1950-1970



purchases, yet some overall absolute growth has taken place due to increased exports. For the past decade, exports have ranged from a high in 1961 of 27.2 percent of purchased scrap to a low of 13.7 percent in 1966, as can be seen from Table V-28.

TABLE V-28. EXPORTS OF TOTAL PURCHASED SCRAP, 1950-1970 (percent)

1950	<0.1	1957	17.9	1964	19.8
1951	<0.1	1958	11.2	1965	14.7
1952	1.0	1959	14.5	1966	13.7
1953	<0.1	1960	23.6	1967	18.7
1954	6.7	1961	27.2	1968	16.4
1955	12.6	1963	17.8	1969	19.7
1956	14.7			1970	23.8

Source: Based on data in Institute of Scrap Iron and Steel yearbooks.

It should further be noted that without the export markets, additional accumulation of ferrous solid waste would occur particularly in coastal areas where low local demand and high freight rates to ship inland prohibit domestic shipment except in times of high scrap prices.

The major types of scrap exported in 1970 were: No. 1 heavy melting - 34.5 percent; No. 2 bundles - 12.8 percent; shredded scrap - 11.0 percent; and No. 2 heavy melting - 10.7 percent. A significantly heavier proportion of obsolete scrap to total scrap is shipped in the export market than in the domestic market. The tonnage and percent trends by type are shown in Table V-29.

TABLE V-29. SCRAP EXPORTS BY MAJOR TYPE, 1960, 1965-1970

Year	#1 Heavy Melting	#2 Heavy Melting	#1 Bundles	#2 Bundles	Borings, Shovelings, and Turnings	Stainless Steel	Shredded	Iron	All Other	Total
					Thousand Net Tons					
1960	2,376	1,247	1,447	1,082	116	N.A.	N.A.	627	1,145	8,040
1965	2,148	943	347	1,450	216	N.A.	N.A.	394	677	6,175
1966	2,210	965	158	1,283	377	N.A.	N.A.	260	574	5,827
1967	2,762	1,151	394	1,509	462	N.A.	N.A.	447	779	7,504
1968	2,482	783	270	969	439	N.A.	N.A.	416	1,206	6,565
1969	3,452	1,009	593	1,038	767	76	--	627	1,475	9,036
1970	3,657	1,139	377	1,356	623	87	1,165	800	1,409	10,613
					Percent of Total					
1960	29.6	15.5	18.0	13.5	1.4	--	--	7.8	14.2	100.0
1965	34.8	15.3	5.6	23.5	3.5	--	--	6.4	11.0	100.0
1966	37.9	16.6	2.7	22.0	6.5	--	--	4.5	9.9	100.0
1967	36.8	15.3	5.3	20.1	6.2	--	--	6.0	10.4	100.0
1968	37.8	11.9	4.1	14.8	6.7	--	--	6.3	18.4	100.0
1969	38.2	11.2	6.6	11.5	8.5	.8	--	6.9	16.3	100.0
1970	34.5	10.7	3.6	12.8	5.9	.8	11.0	7.5	13.3	100.0

Source: 1970 - U.S. Bureau of Mines, Mineral Industry Surveys, Iron and Steel Scrap in January, 1971, dated March 18, 1971.
1960-1969 - ISIS Yearbooks. (These statistics provide a more detailed breakdown than those shown in the U.S. Bureau of Mines Minerals Yearbook. Some slight differences in totals exist.

Japan is by far the largest consumer of export scrap, taking 48.8 percent of the market in 1970. Spain was second with 14.2 percent, followed by Mexico with 7.7 percent, Canada with 6.8 percent, Korea with 6.3 percent, and Italy with 5.1 percent. All others were under 3 percent. The tonnage and percentage trends by countries for the period 1960-1970 are shown in Table V-30.

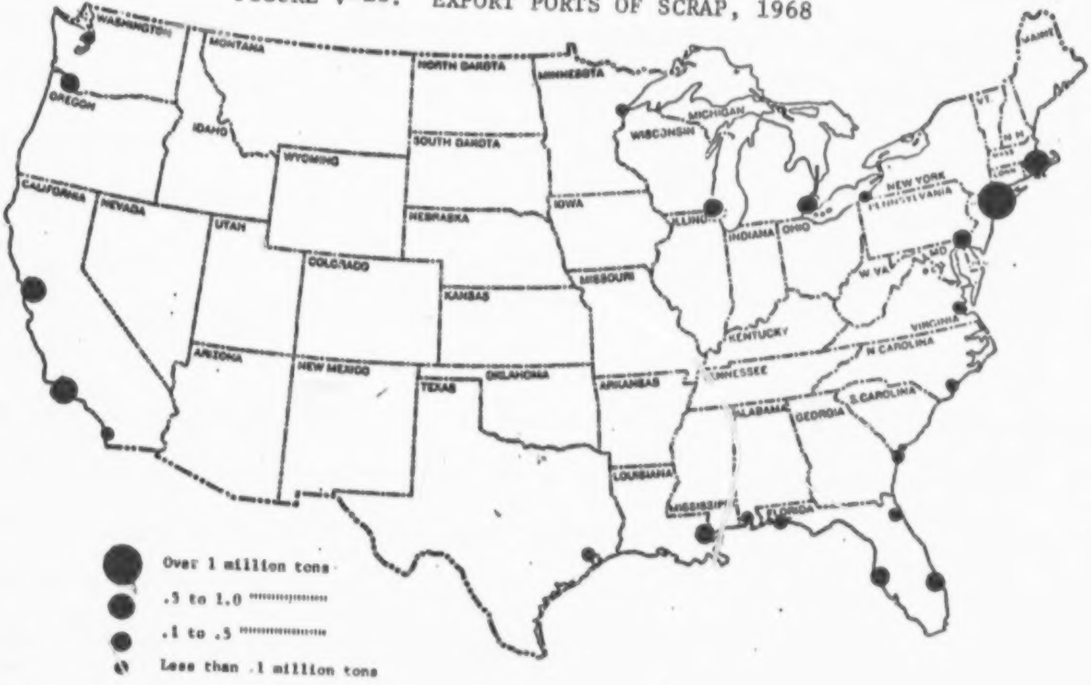
TABLE V-30. FERROUS SCRAP EXPORT DESTINATION, 1960-1970

Year	Japan	Spain	Canada	Italy	Mexico	Korea	Taiwan	United Kingdom	Sweden	West Germany	All Other	Total
							Thousand Net Tons					
1960	3,504	149	533	1,032	426	N.A.	132	249	225	559	1,231	8,040
1965	2,378	117	1,014	764	857	92	336	67	56	28	466	6,175
1966	3,079	86	739	322	780	279	128	1	46	15	353	5,827
1967	5,300	85	542	217	747	307	83	1	28	1	193	7,504
1968	3,387	357	523	729	528	304	195	3	105	57	377	6,565
1969	4,204	1,104	619	879	582	554	115	310	204	93	372	9,036
1970	5,184	1,507	724	540	822	673	208	251	160	59	485	10,613
							Percent of Total					
1960	43.6	1.9	6.6	12.8	5.3	--	1.6	3.1	2.8	7.0	15.3	100.0
1965	38.5	1.9	16.4	12.4	13.9	1.5	5.4	1.1	.9	.5	7.5	100.0
1966	52.8	1.5	12.7	5.3	13.4	4.8	2.2	--	.8	.3	6.1	100.0
1967	70.6	1.1	7.2	2.9	10.0	4.1	1.1	--	.4	--	2.3	100.0
1968	51.6	5.4	8.0	11.1	8.0	4.6	3.0	--	1.6	.9	5.7	100.0
1969	46.5	12.2	6.9	9.7	6.4	6.1	1.3	3.4	2.3	1.0	4.1	100.0
1970	48.8	14.2	6.8	5.1	7.7	6.3	2.0	2.4	1.5	.6	4.6	100.0

Source: Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office, 1960-1970

Major export ports of scrap are shown in Figure V-13.

FIGURE V-13. EXPORT PORTS OF SCRAP, 1968


WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
WYOMING
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
NEW YORK
PENNSYLVANIA
COLORADO
KANSAS
MISSOURI
W VA
MD
KENTUCKY
VIRGINIA
N CAROLINA
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
ARKANSAS
TENNESSEE
S CAROLINA
ALABAMA
GEORGIA
MISSISSIPPI
LOUISIANA
FLORIDA
MAINE
VT
N H
Over 1 million tons
.5 to 1.0
.1 to .5
Less than .1 million tons

Source: Iron and steel scrap, Minerals yearbook, 1968.

The major factors affecting a foreign nation's need for American scrap are basically the same as in this country. They include:

(1) Type of iron and steelmaking furnaces and their scrap usage

(2) Hot metal availability

(3) Generation of own obsolete scrap

(4) Iron and steel production rates

(5) Price of American scrap relative to other metallic sources of supply

(6) Other raw material availability, i.e., coke, iron ore.

The future trends in American scrap exports will undoubtedly be more highly concentrated in those nations with developing iron and steel industries and economies. Evidence of this is already apparent, e.g., Spain and Korea, as can be seen from Table V-29. This could be accelerated if much of the new capacity in those nations is electric furnaces.* In a developing nation, the supply of obsolete scrap is limited internally for a period of years, and adds to the requirements for foreign purchase of scrap. This is not to say that these purchases will necessarily come from the U.S.; for example, as the Japanese economy and steel industry becomes mature and self-sufficient in scrap, it will turn to export markets for its excess scrap generation.

It is therefore difficult to estimate the future growth of American scrap exports, without a country by country analysis of current and projected iron and steel capacity, by type of furnace and steelmaking practice, and of each nation's external scrap needs based upon domestic scrap availability. While not within the scope of this study, it is an area worthy of further consideration and analysis. For example, due to depressed foreign steel production and scrap demand, exports of scrap so far in 1971 have been significantly below 1970's level. This has an obvious negative effect on increased recycling of ferrous solid waste. If our goal is to achieve more effective recycling of American ferrous solid waste, and if domestic markets cannot effectively absorb all that can be made available, a detailed analysis of export markets should be undertaken. In addition, scrap exports exercise a small but positive influence on our international balance of payments.

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*However, metallized ores may offer direct scrap substitutes. An excellent discussion of scrap and metallized ores alternative is contained in Tietig, R., Jr. Possibilities of developing an iron and steel industry with other than fully integrated plants. Kaiser Engineers, 1968.

Other Markets

Copper Precipitation

A growing, but limited, market for iron and steel scrap is the copper mining industry. Of the total 1.5 million tons of copper mined annually in the U.S., approximately 15 percent, or 200,000 tons is obtained by leaching lean ore deposits or tailings with sulfuric acid to obtain copper sulfate; the copper is then precipitated out of the leach solution by the substitution of iron for copper, according to the chemical equation $Fe+CuSO_4 \rightleftarrows Cu+FeSO_4$. This product is known as cement copper. A flow diagram for dump leaching and iron precipitation and a typical design of a gravity launder-precipitation plant are shown on the next page (Figures V-14 and V-15).

Ferrous scrap with a large surface area per unit of weight is well suited for this process, making this an ideal application for obsolete steel cans or prompt industrial scrap from can-making processors. In practice, the range of iron consumed per ton of copper produced is 1.5 to 2.5 tons of scrap per ton of copper. It is currently estimated that 400,000 tons of ferrous scrap are consumed in this market annually. The cans are normally burned first to remove paper labels and organic materials, with the tin often removed by a caustic leach process, and followed by shredding. Scrap punchings and clippings produced during can-making or detinned scrap are particularly attractive for this application due to their relative uniformity of size and absence of organic materials.

FIGURE V-14. FLOW DIAGRAM FOR DUMP LEACHING AND IRON PRECIPITATION

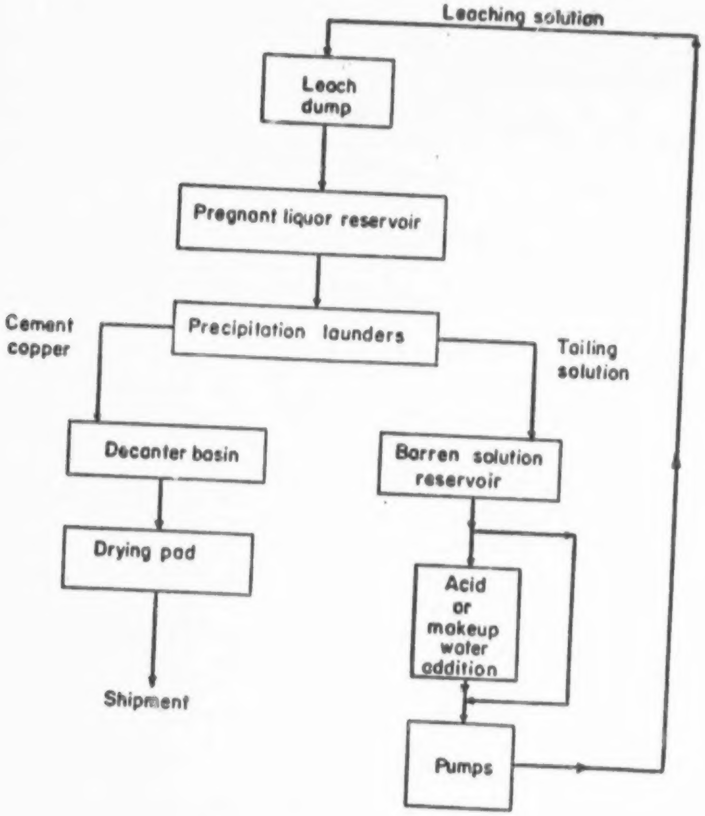
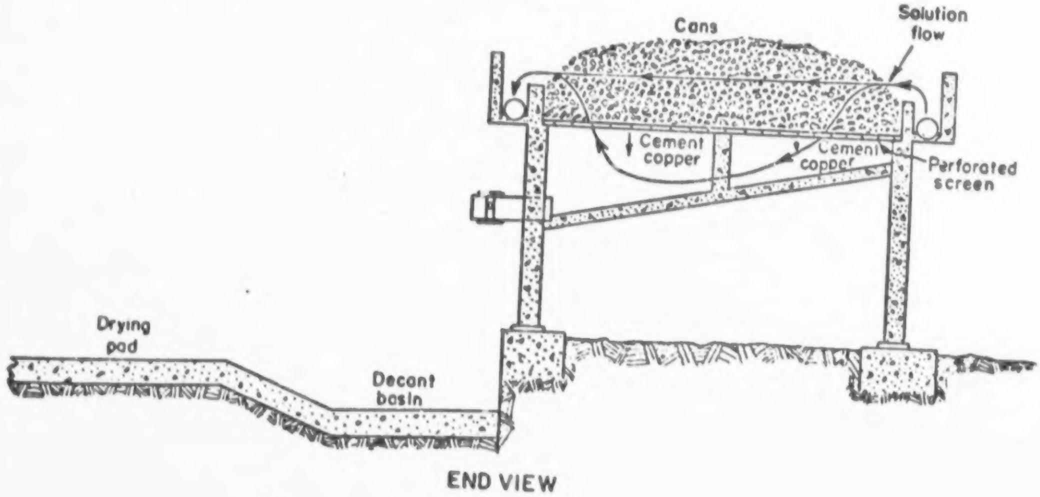

Leaching solution
Leach dump
Pregnant liquor reservoir
Cement copper
Precipitation launders
Tailing solution
Decanter basin
Barren solution reservoir
Drying pad
Acid or makeup water addition
Shipment
Pumps

FIGURE V-15. TYPICAL DESIGN OF GRAVITY LAUNDER-PRECIPITATION PLANT


Cans
Solution flow
Cement copper
Cement copper
Perforated screen
Drying pad
Decant basin
END VIEW

Three major obstacles exist to increased utilization of scrap for this application. In the long run, the maximum market for scrap used for copper precipitation is estimated at about three times its current utilization, or 1 to 1.5 million tons annually. This is a relatively small market for the 5 million tons of cans produced each year. In addition, competing extraction processes, such as electrowinning, are also used for extraction of copper from lean ore deposits. Thirdly, the location of the copper mining industry in western United States and the transportation costs to get the cans to that location prohibit significantly increased usage over today's levels. An approximate breakeven point on scrap sources due to the freight rates involved has Chicago as the easternmost area from which cans can be economically collected. Thus, well over 50 percent of total can consumption, based on a close correlation with population, lies outside economical reuse by the copper mining industry.

Two possible solutions, which require further study, may offer increased utilization of scrap in this market. The Bureau of Mines studied the precipitation of copper from dilute acidic sulfate solutions using shredded automobile scrap in a rotary drum.(5) Their tests indicated that this type of scrap, in ample supply in the western states, precipitated copper faster and more completely than shredded, detinned, tinplate scrap in a launder, with comparable iron consumption. Although power consumption is required by this method, and the capital costs are higher, faster precipitation and continuous recovery of cement copper, together with the ability to use low cost shredded auto scrap instead of the relatively high cost can scrap appears to offer advantages for this method depending on the volume produced.*

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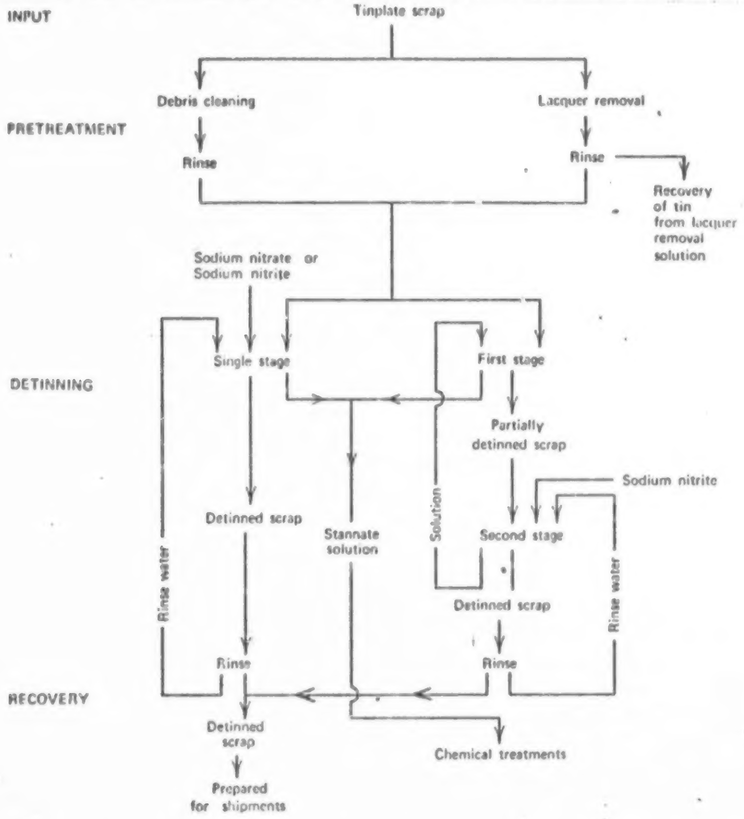
* The Bureau's study cost evaluation used $32/ton for shredded auto scrap and $55/ton tinplate scrap. For a 10 ton per day plant the unit production cost of cement copper was $138.00 for the tumbler method versus $135.14 for the normal gravity launder processing. For a 50 ton per day plant, the respective costs were $128.51 versus $119.54.

Another possible solution would be the establishment of preferential freight rates for can scrap, thereby allowing its economical radius of sources to be expanded.

Detinning

Detinning is a process whereby tin is removed from tin-plated steel by chemical processing. Three commercial processes are used: the alkali-chemical, the alkaline-electrolytic, and the chlorine processes. The most widely used is the alkali-chemical process, where the tin-plate scrap is treated with a hot solution of caustic soda in the presence of an oxidizing agent. The tin is dissolved as sodium stannate; the tin-free steel is then washed and baled for shipment to mills as scrap or to copper precipitation facilities. A flow diagram of the process appears below.

FIGURE V-16. FLOW DIAGRAM OF DETINNING SYSTEM USING TIN-PLATED SCRAP


INPUT
Tinplate scrap
Debris cleaning
Lacquer removal
PRETREATMENT
Rinse
Rinse
Recovery of tin from lacquer removal solution
Sodium nitrate or Sodium nitrite
Single stage
First stage
DETINNING
Partially detinned scrap
Sodium nitrite
Detinned scrap
Stannate solution
Solution
Second stage
Rinse water
Detinned scrap
Rinse water
Rinse
Rinse
RECOVERY
Detinned scrap
Chemical treatments
Prepared for shipments

Source: Kirk-Othmer encyclopedia of chemical technology. 2d ed. v.20. New York, John Wiley & Sons, Inc., 1969. p.298.

The tin-plate scrap is obtained directly from steel mills who produce tin-plated steel, from can and bottle cap makers, and from miscellaneous users of tin-plate. During war-time emergency conditions, used cans have been detinned in substantial quantities, but it is only attractive under those conditions due to the high cost of collecting, transporting, and cleaning the cans, in addition to an excessive consumption of chemicals. It is, however, the largest single source of secondary tin and is virtually untapped. As of 1969, detinning was limited almost exclusively to the scroll cuts at the mills, the trimmings at the can plants, and the spoiled unused cans.

Approximately 800,000 long tons of tin-plated steel scrap is treated annually; with 3,000 short tons of tin recovered, it is an important source of secondary tin. Secondary tin averages 30 percent of total U.S. tin consumption; tin from detinned steel approximates 15 percent of the secondary total.

As can be seen from Table V-31, the amount of scrap treated has increased significantly, but the tin recovery has not. This is a function of the

TABLE V-31. DETINNING OPERATIONS IN THE UNITED STATES, 1933-1970

		Tin Recovered (short tons)			
Year	Scrap Treated (long tons)	As Metal	As Compounds	Total	Tin Recovered Per Long Ton Scrap (lb)
1933	155,844	938	2,008	2,946	37.8
1940	273,232	4,147	697	4,844	35.7
1950	486,235	3,697	644	4,341	18.0
1960	684,247	2,934	734	3,668	10.7
1965	794,500	3,052	756	3,808	9.6
1966	783,433	2,928	762	3,690	9.4
1967	773,605	2,667	486	3,153	9.1
1968	778,346	2,447	492	2,939	8.5
1969*	831,713	2,420	560	2,980	8.0
1970	771,415	1,988	620	2,608	7.6

* 1969 figure not comparable to 1968; 1969 includes one more reporting company.

Source: Tin. In U.S. Bureau of Mines. Minerals yearbook. Washington, U.S. Government Printing Office.

change from hot-dipped to electrolytic tin-plate and thinner tin coatings. The tin per short ton of plate has decreased from 1964's 11.7 pounds to 10.1 pounds in 1969.

Average delivered cost of tin-plate scrap in 1969 was $26.35 per long ton. Imports and exports of tin-plate scrap are about in balance. In 1969, 23,285 long tons were exported; 21,293 tons were imported.

Tin-plating of steel is the largest market for tin in this country, accounting for about 25 percent of total tin consumption. With the inroads being made by tin-free steel--chrome type (TFS-CT) on 40 percent of the total tin-plate markets, the future consumption of tin and its recovery from this source is expected to decrease significantly. The implication is clear--even if economic recovery of steel cans from municipal solid waste is achieved, this outlet for the cans, offering some value for their use, will be limited.

Future Scrap Requirements

It is estimated that domestic ferrous scrap requirements will increase from the 1968-70 average of 89.2 million net tons to 141.4 million net tons by 1985. This increase of 58.5 percent exceeds the anticipated 49 percent increase in production of raw steel and iron and steel castings shipments. Scrap requirements will therefore show a moderate increase per ton of raw steel and castings, from 0.59 to 0.62 ton. The purchased scrap proportion of total scrap consumption should also show a slight increase from 1968-70's 39.1 to 43.4 percent by 1985. Detail is shown in Table V-32.

TABLE V-32. FUTURE DOMESTIC SCRAP REQUIREMENTS
(million net tons)

	1968-70 Average		1975		1980		1985	
	Production*	Requirements	Production*	Requirements	Production*	Requirements	Production*	Requirements
STEEL INDUSTRY								
Basic oxygen furnaces	57.4	19.0	82.0	27.1	105.0	34.7	127.0	41.9
Open hearth furnaces	58.2	27.8	40.0	20.0	25.0	12.5	14.0	7.0
Electric furnaces	19.0	18.2	33.0	32.3	45.0	44.1	59.0	57.8
	134.6	65.0	155.0	79.4	175.0	91.3	200.0	106.7
Blast and misc. furnaces	92.2	7.0	101.0	7.6	112.0	8.5	124.0	9.6
		72.0		87.0		99.8		116.3
IRON AND STEEL CASTING INDUSTRY								
	Shipments		Shipments			Shipments		Shipments
Foundry Furnaces	17.8	17.2	20.0	18.6	23.0	21.4	27.0	25.1
TOTAL SCRAP REQUIREMENTS	---	89.2	---	105.6	---	121.2	---	141.4
PURCHASED SCRAP REQUIREMENTS	---	34.9	---	43.9	---	51.3	---	61.4
PURCHASED OF TOTAL	---	39.1%	---	41.6%	---	42.3%	---	43.4%

*Raw steel and pig iron.

Assumptions

1. Scrap requirements based on 1968-69 average of scrap consumption per ton produced for steel, per ton shipped for iron and steel castings:

Basic oxygen furnace	-	.33
Open hearth	-	.50
Electric	-	.98
Blast	-	.05
Foundry	-	.93

2. Purchased scrap:
   Steel - continuation of 1967-70 home scrap generates at 35 percent raw steel.
   Castings - continuation of 1968-69 purchased at 60 percent of scrap consumption.

3. Increased purchased scrap requirements due to growth in continuous casting will be partially offset by direct-reduced ores.

Sources: U.S. Bureau of Mines. Minerals yearbook. Washington, U.S. Government Printing Office, 1969. Annual statistical report. New York, American Iron and Steel Institute, 1970. 1975-1985 are Battelle-Columbus estimates.

In making these estimates, it was felt that the most reasonable basis of determination was one which considered primarily current technology and economics of iron and steel consumption, factored by the growth in the markets for iron and steel scrap and the changes occurring in the types of iron and steelmaking furnaces used. The estimates are offered simply as a reference framework for planning.

Numerous factors are emerging which could significantly modify these estimates. Major among them are increasing environmental pressures for recycling, growth in continuous casting, availability and economics of direct-reduced ores, foreign trade trends in iron and steel products, and competitive materials inroads on iron and steel products. However, it was felt that it was still too early to enable quantative analysis of these factors and their effects, although such analysis should be possible within the next few years.

In addition, no attempt has been made to forecast the export market for iron and steel scrap, due to the dynamic changes occurring in world scrap demands and usage. This area is a subject for study in its own right, and of particular importance for ferrous solid waste considerations, since significant amounts of export scrap come from obsolete sources.

The major effect of the increased purchased scrap proportion should be felt in the area of obsolescent scrap, the product of ferrous solid waste. No significant change is anticipated in home or prompt industrial scrap generation rates and usage, which correlates closely with iron and steel production. Therefore, the additional scrap should come from the obsolete reservoir. No shortage of supply from this source is anticipated--only 60 percent of the amount becoming available currently is being recycled. In addition, the rate of obsolescence, i.e., shortened life cycle of iron and steel products, will undoubtedly increase in our affluent, disposal-oriented society, making an ever increasing amount available.

TABLE V-33. U.S. RAW STEEL PRODUCTION, SHIPMENTS, AND DOMESTIC CONSUMPTION OF STEEL

(Thousand Net Tons)

Year	Raw Steel Production	Steel Mill Products Net Shipments	Less Exports	Plus Imports	Domestic Consumption
1950	96,836	72,232	2,566	1,014	70,680
1	105,200	78,929	2,764	2,174	78,339
2	93,168	68,004	3,271	1,201	65,934
3	111,610	80,152	2,680	1,703	79,175
4	88,312	63,153	2,534	770	61,389
5	117,036	84,717	3,583	971	82,105
6	115,216	83,251	3,622	1,336	80,965
7	112,715	79,895	4,569	1,145	76,471
8	85,255	59,914	2,429	1,676	59,161
9	93,446	69,377	1,408	4,357	72,326
1960	99,282	71,149	2,563	3,333	71,919
1	98,014	66,126	1,990	3,163	67,229
2	98,328	70,552	2,013	4,100	72,639
3	109,261	75,555	2,224	5,446	78,777
4	127,076	84,945	3,442	6,440	87,943
5	131,462	92,666	2,496	10,383	100,553
6	134,101	89,995	1,724	10,753	99,024
7	127,213	83,897	1,685	11,455	93,667
8	131,462	91,856	2,170	17,960	107,646
9	141,262	93,877	5,229	14,034	102,682
1970	131,514	90,798	7,053	13,364	97,109

Source: Annual statistical reports. New York, American Iron and Steel Institute.

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2. Business & Defense Services Administration. Iron & steel scrap consumption problems. Washington, U.S. Government Printing Office, Mar. 1966. 52 p.

3. [33 Magazine, p.49, July 1970.]

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5. Dean, K. C., R. D. Groves, and S. L. May. Copper cementation using automobile scrap in a rotating drum. U.S. Bureau of Mines Report of Investigations 7182. [Washington], U.S. Department of the Interior, Sept. 1968. 12 p.

CHAPTER VI
THE FERROUS SCRAP PROCESSING INDUSTRY

The vital link connecting the sources and markets of scrap is the ferrous scrap processing industry. With few exceptions, it is through this channel that ferrous solid waste flows to become a valuable raw material resource.

The industry provides three major services to our nation:

(1) Reclamation or recycling of the discarded ferrous products of our society by processing them into raw materials valuable for new products

(2) Conservation of natural resources through the use of these reclaimed materials rather than irreplaceable natural resources

(3) Beautification through the removal and elimination of these discarded materials from our landscape.

If it were not for the ferrous scrap industry, the drain on our natural resources and the increased accumulation of ferrous solid waste would reach monumental proportions with dire consequences for our nation.

In 1970, the total volume of iron and steel scrap handled by all sources approached 100 million net tons. Of this total, home, or mill revert, scrap approximated 53 million net tons, and purchased scrap from the ferrous scrap industry approximated 45 million net tons. For the latter, domestic purchases accounted for about 34 million net tons and exports about 11 million net tons.

The value of the purchased scrap alone approached $2 billion, assuming the average price for No. 1 Heavy Melting Steel Scrap as typical of all scrap purchases. Total employment in the ferrous scrap processing industry is estimated at 40,000.

Functions

The ferrous scrap industry in the United States, from its inception in the 1800's has had as its basic function the recycling of obsolescent iron and steel materials into resources useful for new products. The primary functions of the industry are to collect iron and steel scrap, process it into the physical forms and grades required by its markets, and to manage its purchase and sale. A summary of these functions appears below.

TABLE VI-1. SCRAP PROCESSOR FUNCTIONS

- Collection of Scrap
    1. Arranging with industrial scrap generators to buy and pick up scrap. Sometimes includes special containers and equipment at generators' plants.
    2. Spot buying of scrap from factories, brokers, collectors, and other sources and picking up or arranging for delivery of the scrap.
    3. Buying and taking delivery of scrap brought to the processing yard by individuals, truckers, or others.
- Identification and Segregation of Scrap
    1. Visual and/or instrument segregation of various scrap materials from each other and from waste materials.
    2. Burning-off of organic materials from noncombustible scrap materials.
    3. Magnetic separation of ferrous from nonferrous scrap.
    4. Separation of heavy materials from light materials by air flow.
    5. Separation of low melting from high melting metal scrap by selective melting.
    6. Heavy media flotation of heavy from light materials.
    7. Chemical solution of one material to separate from another.
- Upgrading and Packaging of Scrap
    1. Quality upgrading by mechanical means.
    2. Reducing the size of scrap by torching, shearing, shredding, sawing, or other methods.
    3. Tailoring the size of scrap by baling, bundling, briquetting, or other methods.
    4. Densifying scrap for ease of handling, storage, and shipment.
    5. Manufacturing of waste material into raw material.
- Marketing
    1. Developing sources and markets for scrap.
    2. Buying and selling scrap at a profit.
    3. Providing customer service.

Two other businesses, often mistakenly considered part of the industry yet vital to the flow of iron and steel scrap, are the auto wrecker whose primary function is the disassembly and sale of parts from obsolescent motor vehicles; and the junk collector, who assembles, sorts, and sells all types of waste material. The auto wrecker will be discussed in detail later in this report.

Profile

Three basic types of firms comprise the ferrous scrap industry: the processor, who assembles and prepares the scrap for sale; the processor/broker, who assembles, prepares, and sells the scrap to the consuming markets; and the broker, who buys from the processor or other sources direct, such as prompt industrial scrap from industrial accounts, and sells to the markets direct, with little or no processing on his part. Most of the tonnage is sold through the processor/broker channel. It is estimated that less than 50 firms are pure brokers, about 150 firms are processor/brokers, and the remainder are processors and collectors. The total number of firms in the basic ferrous scrap industry is estimated at approximately 1,800 firms, operating slightly over 2,000 establishments. The national association representing the ferrous scrap industry is the Institute of Scrap Iron and Steel, Inc., whose more than 1,100 member firms handle over 90 percent of purchased iron and steel scrap.

Processing firms range in size from the small localized operation, employing less than 10 people, with a minimal amount of processing equipment, and shipping less than 1,000 tons per month, to the large, geographically spread, capital-intensive firms doing over $100 million of business annually. The vast majority of firms are small family owned and operated enterprises, although a few large publicly held corporations exist.*

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*Among those publicly held corporations having ferrous scrap operations are Commercial Metals Company, Ogden Corporation, Proler Steel Corporation, Roblin Industries, and Steelmet, Inc. A discussion of these firms and other publicly held scrap enterprises is the subject of Lipsett, C. H. The fabulous wall street scrap giants. New York, Atlas Publishing Company, Inc., 1969.

An approximation of the industry structure by size appears in Table VI-2.

TABLE VI-2. FERROUS SCRAP INDUSTRY STRUCTURE

Annual Volume	Percent of Total Firms
>500,000 tons	0.5
300,000-500,000	1.0
100,000-300,000	1.5
60,000-100.000	3.5
30,000-60,000	7.0
<30,000	86.5

Source: Battelle-Columbus estimate.

Other indications of the relative industry structure can be seen in Tables VI-3, VI-4, and VI-5. This information was developed from the Extensive Survey, based on individual establishments. Therefore, direct Comparison with Table VI-2, based on firms, will not prove meaningful.

TABLE VI-3. MONTHLY SCRAP SHIPMENTS BY ESTABLISHMENTS

Volume	Percent of Establishments
<500 tons	33.3
501-1,000	20.5
1,001-2,500	19.0
2,501-5,000	13.8
5,001-10,000	5.6
10,001 and over	7.6
	100.0

Source: Extensive Survey, based on 195 establishments.

TABLE VI-4. TOTAL ANNUAL REVENUE BY ESTABLISHMENTS

Annual Revenue	Percent of Establishments
<$500,000	35.8
$500,000-$1,000,000	18.1
$1,000,000-$3,000,000	27.9
$3,000,000-$5,000,000	9.3
$5,000,000-$7,000,000	3.7
$7,000,000-$10,000,000	1.5
$10,000,000-$15,000.000	2.3
Over $15,000,000	1.4

Source: Extensive Survey, based on 215 establishments.

TABLE VI-5. CAPITAL INVESTMENT IN PLANT AND EQUIPMENT BY ESTABLISHMENT

Total Investment	Percent of Establishments
<$250,000	33.2
$250,000-$500,000	25.5
$500,000-$1,000,000	25.0
$1,000,000-$2,000,000	10.9
$2,000,000-$7,000,000	4.5
$7,000,000-$10,000,000	0.9
Over $10,000,000	0.0
	100.0

Source: Extensive Survey, based on 220 establishments.

Iron and steel scrap establishments are heavily concentrated in the East North Central and Middle Atlantic states, the heart of scrap consumption. These two areas, together with California and Texas, account for over 60 percent of the total. Regional business statistics are shown in Table VI-6 below. The estimated geographic distribution of ferrous scrap establishments are shown in Figure VI-1 and Table VI-7 on the following page.

TABLE VI-6. FERROUS SCRAP INDUSTRY REGIONAL TABULATION OF AVERAGE BUSINESS STATISTICS BY ESTABLISHMENT

		United States Census Region								
Average	National	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Mountain*	Pacific
1969 Gross Sales, thousand dollars	2,032	2,054	1,787	1,080	1,923	2,220	1,692	1,653	250	4,288
Value Plant and Equipment, thousand dollars	763	325	646	375	1,092	868	813	583	375	1,138
Number of Employees	29	18	31	21	28	37	27	29	8	42
Investment per Employee, thousands	26	18	21	18	39	23	30	20	47	27
Sales per Employee, thousands	70	114	58	51	69	60	63	57	31	102
Investment per Dollars of Sales	.16	.36	.35	.57	.39	.48	.35	1.50	.27	.38
Hours Operated per Week	46	44	45	50	50	47	46	42	49	47

Source: Extensive Survey.

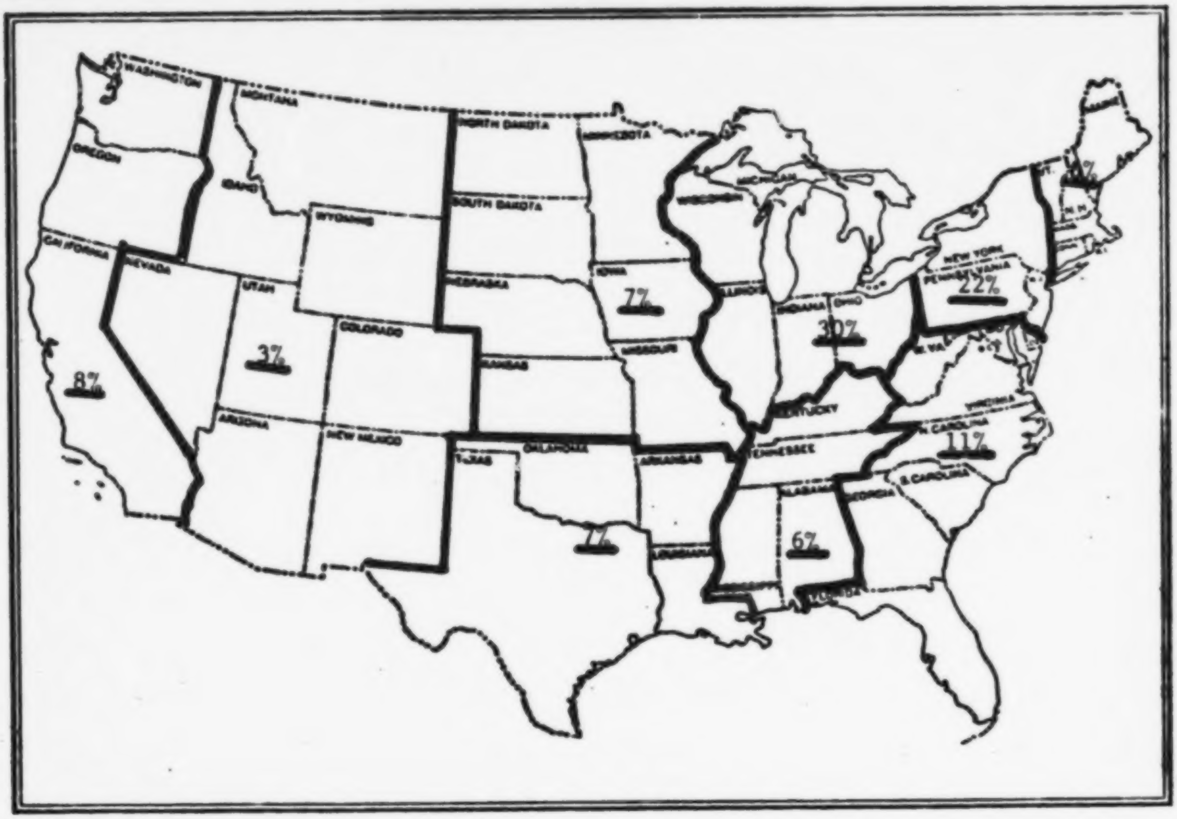

WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
KENTUCKY
TENNESSEE
ALABAMA
GEORGIA
FLORIDA
S.CAROLINA
N.CAROLINA
VIRGINIA
W.VA
NEW YORK
PENNSYLVANIA
VT.
N.H.
MAINE
8%
3%
7%
7%
30%
22%
11%
6%
6%

FIGURE VI-1. ESTIMATED IRON AND STEEL SCRAP PROCESSING ESTABLISHMENTS, 1970 (percent of total by geographic division)

TABLE VI-7. ESTIMATED IRON AND STEEL SCRAP PROCESSING ESTABLISHMENTS, 1970

By Geographic Division	Percent
New England	6.0
Middle Atlantic	22.0
East North Central	30.0
West North Central	7.0
South Atlantic	11.0
East South Central	6.0
West South Central	7.0
Mountain	3.0
Pacific	8.0
	100.0

By Major States	
Over 200 establishments	Pennsylvania, Ohio
100 to 200	New York, Illinois, Michigan, Indiana, California, Texas
50 to 100	Alabama, Massachusetts, Connecticut, New Jersey
25 to 50	Wisconsin, Minnesota, Iowa, Missouri, Virginia, North Carolina, Florida, Georgia, Kentucky

Sources: Battelle-Columbus estimate based on Extensive Survey; U.S. Bureau of the Census. 1967 Census of business. Wholesale trade statistics. Washington, U.S. Government Printing Office; 1969-1970 Directory. Washington, Institute of Scrap Iron and Steel.

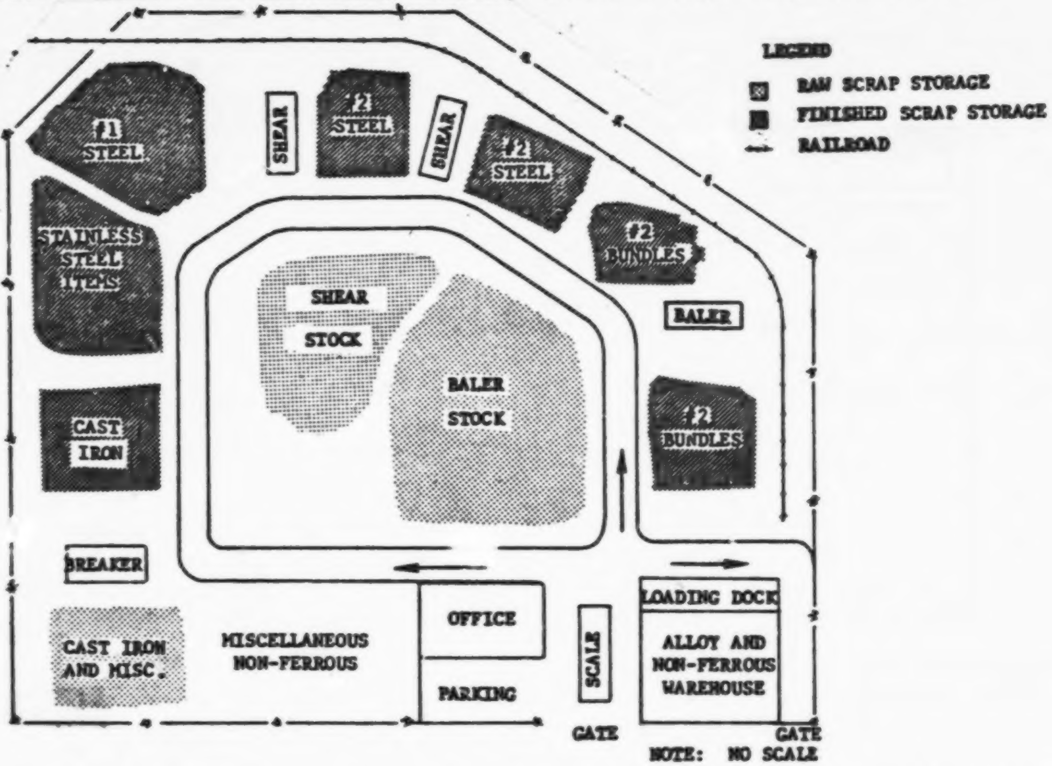
Capabilities

Scrap processing has become an increasingly complex and sophisticated operation, due to the incoming variety of materials and changing requirements of the marketplace. The quality required by the iron and steel producing industries has increased markedly as the requirements of their customers for improved iron and steel products have increased. On the other hand, the complexity and increasing amounts of nonferrous materials used in consumer goods, a major source of obsolete scrap, has made separation and preparation of quality scrap more difficult.

To effectively deal with these trends and increasing labor costs, the scrap industry, together with its equipment suppliers, has developed processing equipment capable of producing quality scrap products. Three major pieces of equipment have contributed to this upgrading. The 1940's witnessed wide-spread installation of hydrualic balers, with their capacity to bundle the increasing amount of light. flat-rolled material. In the late 1950's, the hydraulic guillotine shear and conveyor systems provided properly sized and segregated scrap. However, scrap processing made vast strides in the 1960's with the advent of shredding or fragmentizing equipment, capable of producing the most uniform scrap yet developed from complex consumer goods. But this progress has been expensive, and available only to the larger producers. A continuous flow of material through this equipment is required for profitable operation, a characteristic often lacking in scrap demand.

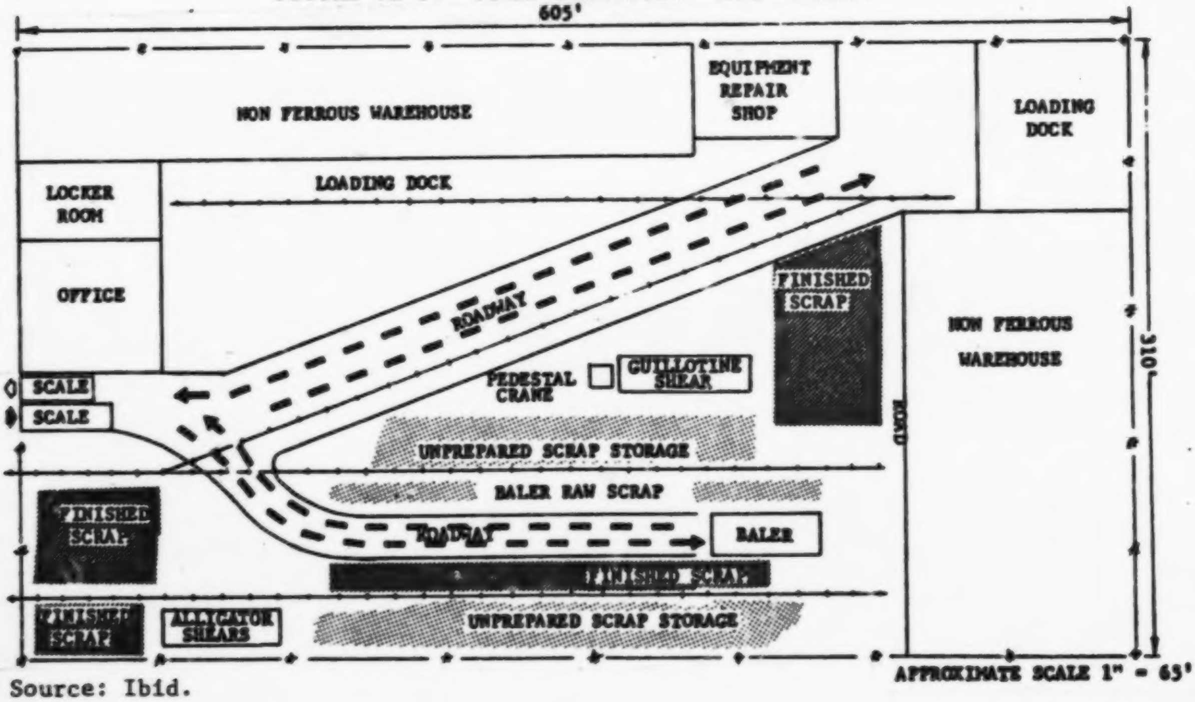
Typical scrap yard layouts appear on the next two pages. Further detail on equipment, its use, problems, and potential for increased recycling of ferrous solid waste appears in the following section.

FIGURE VI-2. CIRCULAR TRAFFIC PATTERN IN SMALL SCRAP PROCESSING YARD


LEGEND
RAW SCRAP STORAGE
FINISHED SCRAP STORAGE
RAILROAD
#1 STEEL
SHEAR
#2 STEEL
SHEAR
#2 STEEL
#2 BUNDLES
STAINLESS STEEL ITEMS
SHEAR STOCK
BALER STOCK
BALER
CAST IRON
#2 BUNDLES
BREAKER
LOADING DOCK
OFFICE
CAST IRON AND MISC.
MISCELLANEOUS NON-FERROUS
SCALE
ALLOY AND NON-FERROUS WAREHOUSE
PARKING
GATE
GATE
NOTE: NO SCALE

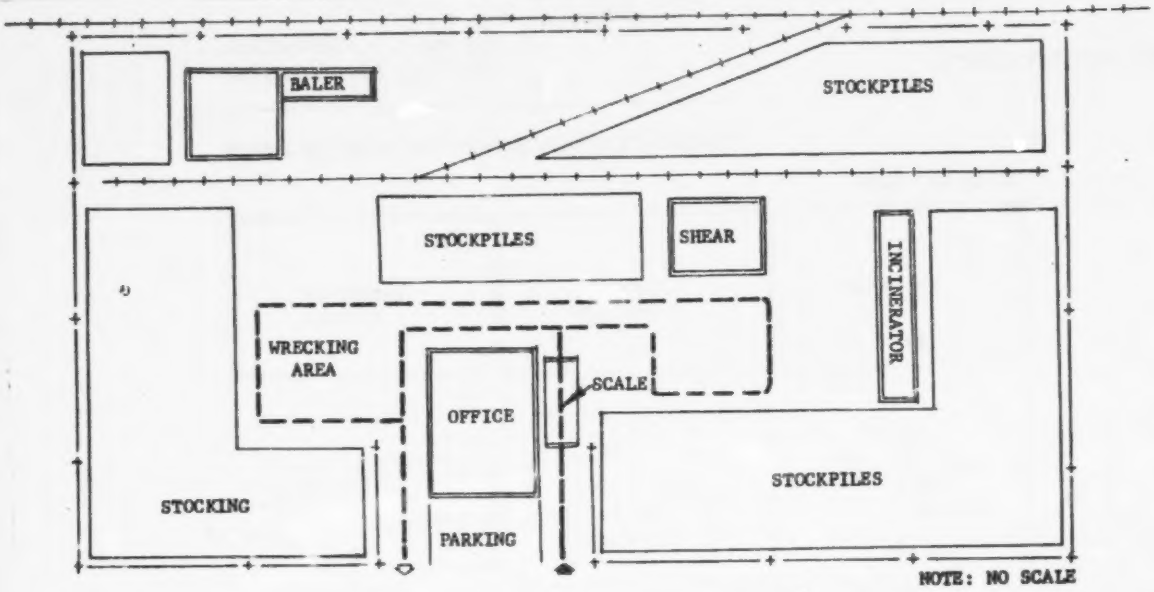
Source: Ralph Stone Company, Inc., study for Scrap Metal Research and Education Foundation and U.S. Bureau of Mines: Resource Reclamation Yard Efficiency, 1969.

FIGURE VI-3. SCRAP PROCESSING YARD LAYOUT


605'
NON FERROUS WAREHOUSE
EQUIPMENT REPAIR SHOP
LOADING DOCK
LOCKER ROOM
LOADING DOCK
OFFICE
ROADWAY
FINISHED SCRAP
NON FERROUS WAREHOUSE
310'
SCALE
SCALE
PEDESTAL CRANE
GUILLOTINE SHEAR
ROAD
UNPREPARED SCRAP STORAGE
BALER RAW SCRAP
FINISHED SCRAP
ROADWAY
BALER
FINISHED SCRAP
FINISHED SCRAP
ALLIGATOR SHEARS
UNPREPARED SCRAP STORAGE
APPROXIMATE SCALE 1" = 65'

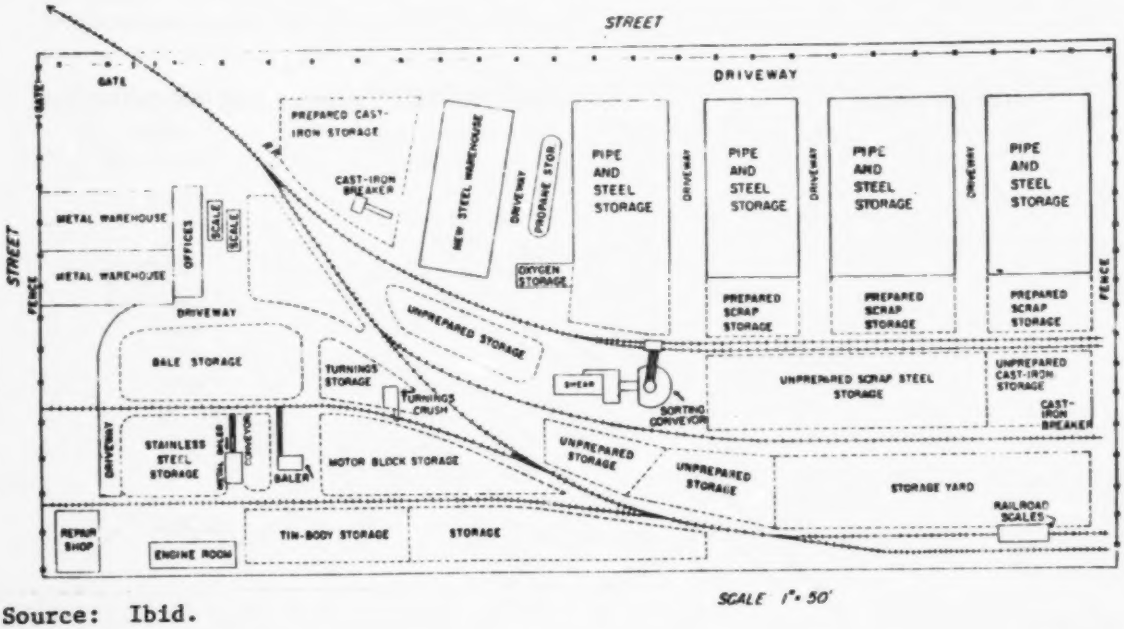
Source: Ibid.

FIGURE VI-4. SCRAP YARD LAYOUT


BALER
STOCKPILES
STOCKPILES
SHEAR
INCINERATOR
WRECKING AREA
SCALE
OFFICE
STOCKING
PARKING
STOCKPILES
NOTE: NO SCALE

Source: Ralph Stone Company, Inc., study for Scrap Metal Research and Education Foundation and U.S. Bureau of Mines: Resource Reclamation Yard Efficiency, 1969.

FIGURE VI-5. SCRAP YARD LAYOUT


STREET
DRIVEWAY
GATE
GATE
PREPARED CAST-IRON STORAGE
R.R.
CAST-IRON BREAKER
NEW STEEL WAREHOUSE
DRIVEWAY
PROPANE STOR
PIPE AND STEEL STORAGE
DRIVEWAY
PIPE AND STEEL STORAGE
DRIVEWAY
PIPE AND STEEL STORAGE
DRIVEWAY
PIPE AND STEEL STORAGE
STREET
FENCE
METAL WAREHOUSE
METAL WAREHOUSE
OFFICES
SCALE
SCALE
OXYGEN STORAGE
PREPARED SCRAP STORAGE
PREPARED SCRAP STORAGE
PREPARED SCRAP STORAGE
FENCE
DRIVEWAY
UNPREPARED STORAGE
BALE STORAGE
TURNINGS STORAGE
TURNINGS CRUSH
SHEAR
SORTING CONVEYOR
UNPREPARED SCRAP STEEL STORAGE
UNPREPARED CAST-IRON STORAGE
CAST-IRON BREAKER
DRIVEWAY
STAINLESS STEEL STORAGE
METAL BALER
CONVEYOR
BALER
MOTOR BLOCK STORAGE
UNPREPARED STORAGE
UNPREPARED STORAGE
STORAGE YARD
RAILROAD SCALES
REPAIR SHOP
ENGINE ROOM
TIN-BODY STORAGE
STORAGE
SCALE 1" = 50'

Source: Ibid.

Capital Equipment

The use of capital equipment in the scrap industry is justified by one or more of the following reasons:

(1) Physical requirements
(2) Productivity
(3) Market and/or product requirements
(4) Regulation.

The physical characteristics of the raw material or the prepared scrap in many cases requires that other than hand labor be used in handling or processing the material.

One method of increasing productivity in the scrap industry is through the utilization of equipment as an adjunct to or in place of manual labor. With labor rates and associated labor problems increasing it is expected that equipment utilization will also increase as a replacement for manual labor. It has been suggested that many of the labor problems faced by scrap processing industry are caused in part by undesirable working conditions which, in many cases, are caused by a lack of capital equipment and the corresponding need for hand labor.

In addition to physical handling requirements and as a method to increase productivity, capital equipment is used to satisfy product or market requirements. For example, shears are used primarily to produce a product of acceptable size, shredders are used to liberate the desired scrap material from the raw material such as auto bodies or insulated wire, and balers are used to produce a product that is easy to handle, ship, and use.

Capital equipment is also used to satisfy governmental or other imposed regulation. For example, air pollution control equipment is used to comply with local or national pollution codes, while fences and buildings may be required to satisfy local codes and ordnances.

Two Perspectives. The scrap industry appears to view the use of capital equipment from two different perspectives. The first view is that processing equipment represents a revenue-generating or profit-making asset. The second view (still held by many firms but a decreasing percentage of the industry) is that processing equipment is a necessary evil--"we use it because we have to"--.

It appears that a larger number of companies in the industry are now viewing the use of capital equipment as a way to generate additional revenue and profit. One factor that is, in a sense, forcing this attitude change is the cost and availability of good quality labor. In many cities it is not only expensive but almost impossible to employ a gang of laborers to prepare scrap and thus, it becomes necessary to turn to equipment.

The second view (necessary evil) probably stems from the commercial and trading orientation of a significant segment of the industry. This segment would prefer to never see the raw material much less actually process it into prepared scrap. Consequently, in some cases, capital equipment purchases tend to be defensive in nature, sometimes ill conceived, and in some cases, without sufficient planning regarding selection, installation, and utilization. There appears to be a definite trend away from this viewpoint motivated by the increasing complexity of the industry, the need for a viable replacement for manual labor, and the realization that processing equipment is a true asset.

Types of Capital Equipment. Almost all scrap processing operations fall into one of the following categories:

- Collection
- Separation
- Upgrading
- Packaging
- Shipping.

In addition to the above, capital equipment is also used in conjunction with disposal of waste material and the general function of material handling. Table VI-8 expands this functional list into specific types of equipment along with typical uses for that equipment and a discussion of the problems and benefits associated with the type of equipment.

Recent Developments in Processing Equipment. During the 1960's much progress was made in processing technology and equipment utilization. In addition to the auto shredder there was widespread adoption of the shear, which when integrated into a system along with picking or sorting conveyors helps produce a more uniform quality of scrap. For example sheared automobile slabs, by their very nature contain less dirt, rust, and ash than No. 2 bundles. In addition, the 1960's saw the growth of obsolescent vehicle disassembly lines, not only for sheared slabs, but also for bundles. In these operations, nonferrous metals are removed by workers who travel in teams down lines of old cars.

The 1960's also brought the development of high compression briquetters which helped to improve the marketability of briquetted turnings; the hot briquetting machine to handle cast iron borings; and the motor block breaker and associated equipment providing cleaner foundry scrap.

New Developments in Processing Equipment. There are several new developments in the area of scrap processing equipment and scrap processing technology that deserve mention. These are listed and discussed below.

(1) Cryogenic Shredding Process. This process developed in Europe freezes the shredder charge in liquid nitrogen prior to shredding. It is claimed that this process produces a cleaner, less contaminated scrap with less energy consumption than conventional shredding processes. At present the major obstacle to wide-spread adoption of this process

TABLE VI-8. IDENTIFICATION AND ANALYSIS OF SCRAP PROCESSING EQUIPMENT

Equipment	Function(s)							Typical Uses	Analysis
	Collection	Separation	Upgrading	Packaging	Materials Handling	Disposal	Shipping		
Mobile Auto Crusher	X			X				(1) Reduce shipping volume for auto hulks. (2) Produce improved shredder feed. (3) May make auto hulk processing economical for remote areas.	(1) Appear to be gaining popularity. May be partial answer to abandoned auto problem.
Baler, Press, Briquetter			X	X				(1) Increase density of scrap for shipment. (2) Produce scrap that is easier to handle, store, and ship. (3) Produce a "sized" product.	(1) Contamination has been and continues to be a problem. Lower quality product. (2) Seems to be losing popularity to shredded scrap in many markets.
Refuse Compactors, Containers	X				X	X	X	(1) Supplier depository for raw material. (2) Material handling. (3) Part of disposal scheme for solid waste generated during processing. (4) Storage and shipment of high value scrap.	(1) Higher densities are desirable from a collection cost standpoint. (2) Reduces pilferage. (3) Prevents contamination. (4) Encourages generator segregation.
Shredder, Impact Grinder, Mill Hammermill, Crusher, Hogger, Battery Breaker, Fragmentizer		X	X	X				(1) Liberates desired raw material from other components. (Insulated wire and auto bodies for example). (2) Reduce size prior to baling. (3) Produce cleaner scrap. (4) Upgrade (turnings, etc.)	(1) This type of equipment is inherently self destructive and requires extensive maintenance both emergency and preventive. (2) This type of equipment is the heart of any scrap handling system. Much care must be taken in selecting proper model, size, etc. (3) Raw material supply is critical along with assured markets for scrap. (4) Need for lower energy mills that do not require extreme maintenance. (5) May require continuous operation to be profitable.

TABLE VI-8. IDENTIFICATION AND ANALYSIS OF SCRAP PROCESSING EQUIPMENT (cont'd)

Equipment	Function(s)							Typical Uses	Analysis
	Collection	Separation	Upgrading	Packaging	Materials Handling	Disposal	Shipping		
Shears, Torches, Saws		X	X	X				(1) Reduce size of scrap to marketable size. (2) De-package.	(1) Popular because of versatility
Scale	X					X	X	(1) Record weight of incoming and outgoing material	(1) No scrapyard can operate without scales. (2) Basis for all financial transactions on the buying end.
Conveyors, Fork Lift Trucks, Other Mobile Materials Handling Equipment					X		X	(1) Physically move raw material and scrap from one point to another. (2) Automated loading for shipment. (3) Combination of conveying and vibratory separation.	(1) Need for developments in the design of automated materials handling equipment for the scrap processing industry. (2) Has been a neglected area from technology standpoint.
Separators--Magnetic, Heavy Media, Air, Screens, Chemical		X	X					(1) Remove impurities prior to shipment. (2) Separation prior to processing to increase capacity of unit or to divert for separate processing.	(1) Most separation processes are still hand operations. (2) Offers opportunity to obtain more revenue (yield) per ton processed. (3) Special purpose separators are available but are difficult to convert to general purpose.
Furnaces--Sweat, Incinerator, Dryers		X	X	X		X		(1) Liberation of raw material from combustible components (auto body, insulated wire). (2) Separate metals by melting point. (3) Produce pigs, etc., for easier shipping, storage, analysis, etc.	(1) Sweat furnaces may be a feasible method for separating white metals from nonmagnetic auto shredder output. (2) Incineration may again become an economical method of separation as improved pollution control equipment becomes available. (3) Often violate pollution codes.

TABLE VI-8. IDENTIFICATION AND ANALYSIS OF SCRAP PROCESSING EQUIPMENT (cont'd)

Equipment	Function(s)							Typical Uses	Analysis
	Collection	Separation	Upgrading	Packaging	Materials Handling	Disposal	Shipping		
Cranes--Magnetic, Grapple					X			(1) Physically move material during processing, loading, and unloading.	(1) Magnet capacity has reached the upper limit. Any increases will now come from new technology. (2) Is an inefficient method of material handling.
Pollution Control Equipment						X		(1) Allow the use of pollution generating processing equipment.	(1) While solutions are available for most operations, they tend to be very expensive. (2) Selection of equipment often requires trial and error.
Over-the-Road Trucks	X						X	(1) Collection and shipping of material.	(1) Becoming a necessary function in many areas in order to obtain a supply of raw material. (2) A sector of the secondary materials industry is becoming service oriented.
Identification Equipment--file, chemicals, spectrographs, etc.	X	X				X		(1) Grade raw material and prepared scrap. (2) Establish prices. (3) Controlling specifications.	(1) Automatic identification and sorting equipment not currently available. (2) Much of this type of equipment requires a skilled operator. (3) Most identification processes are manual.
Scrap Handling Systems		X	X	X	X	X		(1) Handle entire processing operation from receipt of raw material through loading for shipment.	(1) Necessarily inflexible--requires specialization. (2) Expensive but perhaps very profitable for a high tonnage operation. (3) Assured sources of supply and markets for product are necessary.
Systems to handle municipal wastes	X	X	X	X	X	X		(1) Handle municipal solid waste as an alternative to disposal. (2) Extract marketable materials from solid waste and sell. (3) Dispose of remaining material through normal channels.	(1) Not yet economical. (2) Not yet being considered as a viable alternative to disposal. (3) Government sponsored demonstration projects currently in process and to be funded in near future should assist development of feasible systems.

is the high cost of liquid nitrogen which makes the process cost about the same as conventional shredding.

(2) Combination Shredder-Ripper - Two Stage Shredding Process. This process is also aimed at reducing the power required in shredding auto bodies. Power reduction in shredding is desirable from both an operating and a maintenance cost basis since both are directly related to the amount of power used. In the combination shredder-ripper process a relatively slow speed-low power ripper is utilized to literally rip the auto bodies into smaller pieces. The shredder (now necessarily smaller than conventional) then reduces the scrap to its final "fist-sized chunks".

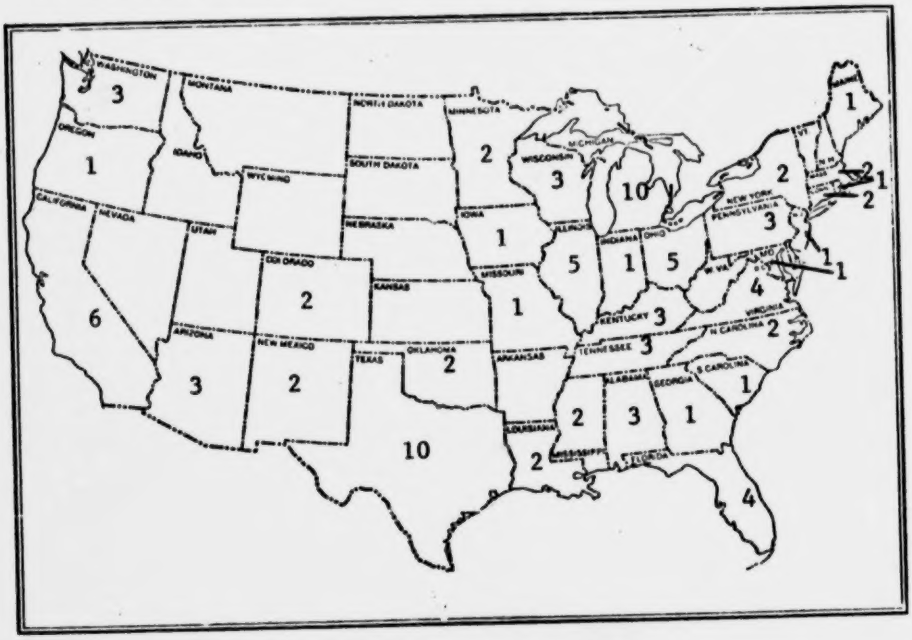
(3) Scrap Separation Techniques. Techniques are being developed and tested to separate scrap metals on a continuous basis much the same way ore is separated from gangue in the mineral processing industries. Techniques such as flotation, air separation, and heavy media separation may provide an economical method of segregating nonferrous shredder discharge on a continuous basis.

(4) Mobile Auto Crushers and Flatteners. Widespread use of mobile auto crushers and flatteners and perhaps even mobile balers or shredders could greatly effect the collection and processing of obsolete scrap. Just as the mobile flattener has been able to reduce the cost of transporting the auto hulks to the scrap processor, mobile processing equipment may be able to eliminate the transportation to the processor and prepare the scrap for direct shipment to the consumer. The mobile auto flattener makes it possible to ship 16-24 auto hulks on a truck that normally hauls 5-7 unflattened hulks.

Impact of the Auto Body Shredder. The introduction of the first commercial auto body shredder in 1961 was perhaps the most significant processing and technological development in the scrap industry for many years. In the 10 years since 1961, there have been roughly another 100 shredder installations. Figure VI-6 shows the geographic location by state for all known shredder installations.

The 96 shredder installations represent a combined shredding capacity of approximately 5 - 7 million tons per year.* Table VI-9 shows the regional breakdown of the estimated shredding capacity, along with a comparison of percentage of shredding capacity with percentage of auto registrations.

FIGURE VI-6. GEOGRAPHIC ANALYSIS OF SHREDDER LOCATIONS


WASHINGTON
3
MONTANA
NORTH DAKOTA
MINNESOTA
2
OREGON
1
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
3
MICHIGAN
10
NEW YORK
2
1
2
1
2
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
1
ILLINOIS
5
INDIANA
1
OHIO
5
PENNSYLVANIA
3
1
1
COLORADO
2
KANSAS
MISSOURI
1
W. VA.
4
VIRGINIA
6
KENTUCKY
3
N. CAROLINA
2
TENNESSEE
3
ARIZONA
3
NEW MEXICO
2
OKLAHOMA
2
ARKANSAS
S. CAROLINA
1
TEXAS
10
ALABAMA
GEORGIA
2
3
1
LOUISIANA
2
MISSISSIPPI
FLORIDA
4

Source: Institute of Scrap Iron and Steel

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* Assuming an annual capacity of 75,000 tons per shredder which is equal to 25 tons per hour, 12 hours per day, 250 days per year, or 4.8 million tons on a one shift basis.

On the basis of the estimated capacities presented below there may be a need for increased shredder capacity in the Middle Atlantic Region.

TABLE VI-9. ESTIMATED SHREDDER CAPACITY FOR EACH U.S. CENSUS REGION*

Region	Number of Shredders	Estimated Capacity (tons)	Total U.S. Shredder Capacity, percent	1970 U.S. Auto Registrations, percent
New England	6	450,000	6.3	6.1
Middle Atlantic	6	450,000	6.3	19.2
South Atlantic	14	1,050,000	14.6	15.5
East North Central	24	1,800,000	25.0	22.1
East South Central	11	825,000	11.5	4.9
West North Central	4	300,000	4.2	7.8
West South Central	14	1,050,000	14.6	8.5
Mountain	7	525,000	7.3	3.6
Pacific	10	750,000	10.4	12.5
National	96	7,200,000	100.0	100.0

* Assumed capacity of 75,000 tons per year per shredder.
Source: Battelle-Columbus estimates.

A simple automobile shredding system is shown in Figure VI-7. It consists basically of a 1000-4000 horsepower impact crusher or hammermill to reduce the auto body into small chunks and a magnetic separator to separate the liberated ferrous fraction from the nonferrous fraction. Auxiliary equipment necessary for the system to operate include primarily motors, conveyors, and a dust collection system.

More complicated systems might add secondary magnetic separation, supplementary separation processes to segregate the nonferrous fraction into metallic and nonmetallic fractions, or possibly a size control on the shredder output to control the physical size of the scrap output. Figure VI-8 is a process flow

FIGURE VI-7. JEFFREY #913 AUTOMOBILE SHREDDING SYSTEM

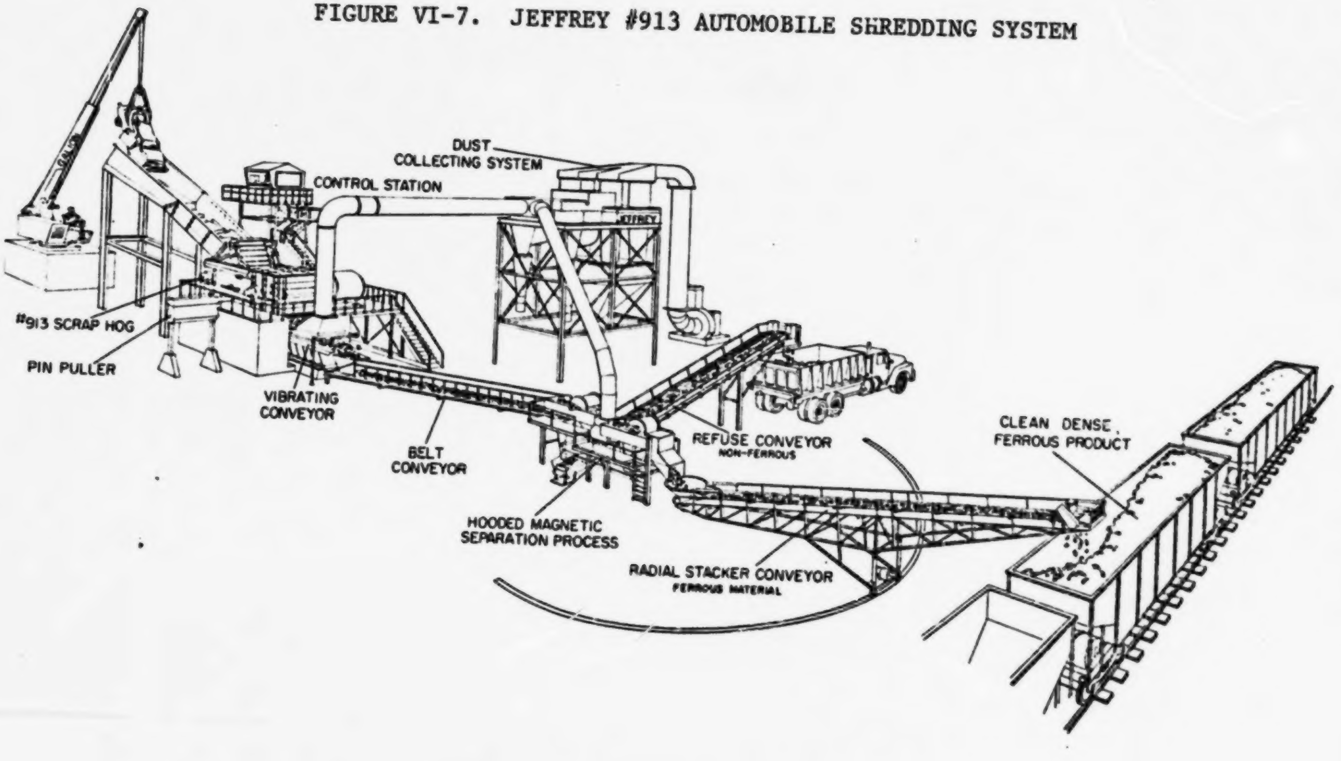
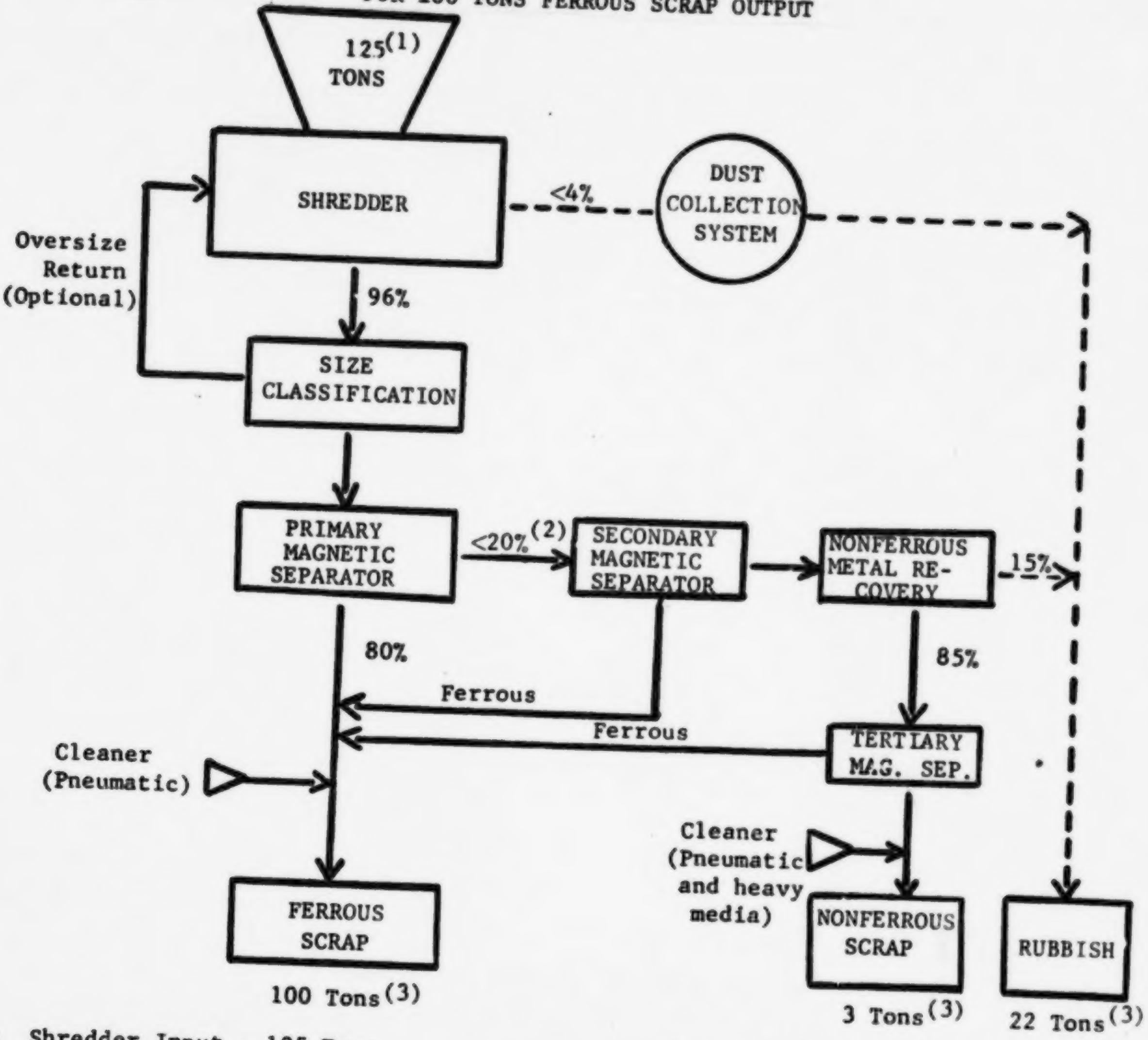

DUST COLLECTING SYSTEM
CONTROL STATION
#913 SCRAP HOG
PIN PULLER
VIBRATING CONVEYOR
BELT CONVEYOR
REFUSE CONVEYOR
NON-FERROUS
HOODED MAGNETIC SEPARATION PROCESS
RADIAL STACKER CONVEYOR
FERROUS MATERIAL
CLEAN DENSE FERROUS PRODUCT

FIGURE VI-8. TYPICAL SHREDDER SYSTEM SIMPLIFIED FOR 100 TONS FERROUS SCRAP OUTPUT


125(1) TONS
SHREDDER
<4%
DUST COLLECTION SYSTEM
Oversize Return (Optional)
96%
SIZE CLASSIFICATION
PRIMARY MAGNETIC SEPARATOR
<20%(2)
SECONDARY MAGNETIC SEPARATOR
NONFERROUS METAL RE-COVERY
15%
80%
85%
Ferrous
Ferrous
TERTIARY MAG. SEP.
Cleaner (Pneumatic)
Cleaner (Pneumatic and heavy media)
FERROUS SCRAP
NONFERROUS SCRAP
RUBBISH
100 Tons(3)
3 Tons(3)
22 Tons(3)

(1) Shredder Input - 125 Tons
85% automotive (exclusive of tires, wheels, power trains, gas tanks, valuable nonferrous)
15% consumer durables (appliances, etc.)

(2) Main Nonferrous Stream - 23 Tons
ferrous - 5%
nonferrous - 15%
rubbish - 80%

(3) System Output - Tons
100 - ferrous scrap(4)
3 - nonferrous

	Percent
zinc die castings	65
aluminum (cast & wrought	15
red metals	13
nonmetallics--red metals	5
nonmagnetic stainless	<2
entrapped ferrous	<1

22 - rubbish (rubber, glass, plastics upholstery "fuzz")

(4) Ferrous Scrap Chemistry, Percent

Cu	0.22
Cr	0.16
Ni	0.10
Sn	0.025
Mo	0.015

sheet for a more complicated system. Table VI-10 presents an analysis of the typical product output of a shredder system.

TABLE VI-10. TYPICAL SHREDDER SYSTEM INPUT AND OUTPUT

Product	Amount (tons)
Input	125
85 percent automotive	
15 percent consumer durable	
	125
Output	
Ferrous scrap	100
Nonferrous scrap	3
65 percent zinc die cast	
15 percent aluminum die cast	
13 percent red metals	
7 percent miscellaneous	
Rubbish, dirt, dust, fabric, etc.	22
	125

Shredding systems are expensive to purchase and expensive to maintain. Profitable operation requires a high volume operation, efficient maintenance procedures, and adequate market and raw material supply conditions.

Installed cost of a typical system to handle approximately 30-40 tons per hour would be around $750,000. Operating costs usually are between $10 and $15 per ton and may be broken down as follows.

Operation	Typical Percent of Total Costs	Total Cost Per Ton
Labor	25	$3.13
Maintenance	20	2.50
Utilities	8-10	1.25
Financial	25-30	3.12
Other (including rubbish disposal)	20	2.50
	100	$12.50

Major problems inherent in operating shredder systems include the economical separation and disposal of the nonferrous fraction, disposal of rubbish and dirt (which may amount to over 100 tons per day), maintenance of the hammermill, and maintaining an adequate supply of raw material. A recent survey of nine large shredder operations conducted by the Bureau of Mines revealed some interesting information as summarized in Table VI-11.

What Can Be Done. The typical scrap processing operation is not extremely efficient especially when compared to some of the mineral or chemical processing industries. There are, of course, many differences between processing scrap and processing ore, but, there still exist several areas in which the scrap processor might improve his operation. For example, one of the major costs of processing is the repeated handling of scrap prior to, during, and after processing. A processing operation designed to minimize repeated handling would certainly improve the plant's overall efficiency.

There are two characteristics of the typical scrap processor which work counter to the development of an efficient scrap processing operation. In the first place, processing costs in the scrap industry average less than 20 percent of total cost while raw material costs often reach 80 percent of total cost. With this cost structure the industry is somewhat reluctant to invest in processing equipment or process modification. Second, the scrap processor is, in many cases, just too unspecialized to invest in an efficient but specialized process scheme. In most cases, processors feel they can make more profit by spending time and money on trading than on processing.

A case in which mineral processing techniques were successfully applied to the scrap industry was the commercial use of shredding systems employing a set process flow as shown in Figure VI-8. It is generally felt that perhaps the best place to apply high volume processing schemes is in the upgrading of complex scrap

TABLE VI-11. SELECTED SHREDDER SURVEY RESULTS, 1969

General		
Average annual capacity(1)		100,000 net tons
Production as a percent of capacity		89 percent
Auto hulks percent of raw material		82.7 percent
Shredded scrap yield per hulk		1,780 pounds
Price range paid for hulks		$12-20
Parts removed prior to shredding		Engine, transmission, gas tank, tires, seats, radiator, battery
Transportation		
Distance from source to shredder operation		
0-9 miles		8.2 percent
10-24		14.8
25-49		48.2
50-99		15.1
100-199		8.9
200-299		3.9
300 and over		1.0
		100.0 percent
Maximum distance for unflattened hulks		100 miles
Minimum distance for flattened hulks		10 miles
Hulks received in flattened condition		40.2 percent
Number of flattened hulks/truckload		
12-25		81.0 percent
25-40		19.0 percent
Number of unflattened hulks/truckload		
2-4		18.6 percent
5-6		39.6 percent
7-8		41.8 percent
Maximum domestic distance shipped		320 miles
Primary mode of shredded scrap shipment		Rail
Properties of Shredded Scrap		
Chemistry range:		Percent
carbon		.05-.32
sulphur		.02-.045
phosphorous		0-.02
copper		.13-.30
chromium		.09-.27
manganese		.07-.275
nickel		.09-.12
silicon		.20-.21
tin		.024-.03
lead		.01-.014
molybdenum		.01-.025
vanadium		.008-.025
Average density range		57-80 pounds/cubic ft
Markets		
Markets for shredded scrap		
Domestic		74.0 percent
nonintegrated steel mills	16.9 percent	
foundries	51.4 percent	
integrated steel mills	5.7 percent	
Exports		26.0 percent
		100.0 percent
Melting furnace distribution		
Open hearth		13.4 percent
Electric		34.2 percent
Cupola		52.4 percent
		100.0 percent

(1) 2,080 hours/year (40 hours/week, 52 weeks).

Source: Based on the results of a survey conducted by the Bureau of Mines in August, 1970, of nine representative (size and location) shredding operations, with a rated capacity of 21 percent of total U.S. capacity of 4.5 million tons in 1969. This information was released July 15, 1971.

such as the automobile. The same could be applied (with modification) to any mixed scrap to increase the value and improve the economics of processing. The basic processing steps include liberation through crushing, ripping, or fragmenting: segregation through magnetic separation or flotation techniques; and packaging through direct loadout, briquetting, or production of secondary pig. To be sure, most scrap processing operations perform these same steps but relatively few integrate the steps into an efficient package.

The Role of Capital Equipment in Recycling. Processing equipment presents the scrap processing industry with a "tool" to assist it in widening the opportunities for increased utilization of solid waste. Specifically, equipment offers assistance by:

(1) Increasing Productivity. Replacement of manual labor by equipment increases the productivity of the scrap processing operation. Thus it may be possible to increase the production rate which in time and in a macro sense should increase the relative amount of solid waste that is recycled.

(2) Increasing Yields. The use of capital equipment in many cases will increase the marketable yield that may be obtained from raw material. In addition, equipment can make it economically feasible to process certain raw materials that, in the past, were not economical to process. For example, sophisticated separation processes may make it feasible and profitable to process some of the "complex scrap" not now being processed.

(3) Enhancing the Competitive Position of the Secondary Materials Industry Relative to the Primary Industry. Equipment offers the secondary materials industry an economical method to produce a competitive

(specification and price) product. The result could be expanded markets for secondary materials and an opportunity to increase the utilization of solid waste.

Survey Data on Equipment Usage. The extensive survey yielded some interesting information on equipment ownership and total capital investment by the ferrous scrap industry. This information is presented in the following pages.

Table VI-12 presents extensive survey results relative to equipment ownership. The percent of the firms owning various types of equipment ranges from a high of 93.5 percent of the firms owning one or more trucks to a low of 6.1 percent and 8.5 percent of the firms owning one or more car flatteners and shredders respectively. The total number of each is reported along with Battelle's estimate of the total number of each type in the entire industry. Finally, the distribution of ownership by region is presented.

Table VI-13 presents the percentage distribution of iron and steel processors (203 out of the 249 extensive survey sample indicated that they were processors and or brokers of iron and steel) with indicated capital investments classified by total 1969 revenue, number of employees, and hours of weekly operation. It is interesting to note that only 2.5 percent of the firms sampled operate more than two 5-day shifts per week. This indicates that the industry has significant reserve capacity to process scrap.

Table VI-14 looks at the average capital (plant and equipment) investment on a regional basis. For the entire United States, the average capital investment is slightly more than $750,000 which represents an average investment of $24,000 per employee and $0.37 per dollar of annual sales.

TABLE VI-12. REGIONAL CENSUS OF EQUIPMENT

Type of Equipment	Percent of Firms Reporting Ownership	Total Number Reported	Projected Number in Entire Ferrous Scrap Industry	Percent of Projected Number of Each Type of Equipment in Each Census Region								
				New England	Middle Atlantic	East South Atlantic	East North Central	West South Central	West North Central	South Central	Moun-tain	Pac-fic
Baler or press	75.3	339	2,198	21.6	18.7	11.3	20.2	7.1	3.3	8.6	0.3	8.9
Railroad siding	80.6	384	2,490	3.4	20.7	10.0	28.1	13.4	7.1	7.3	0.8	9.4
Shredder	8.5	31	96(2)	16.7	16.7	3.3	26.7	6.7	6.7	3.3	0.0	20.0
Alligator shear	83.4	408	2,646	6.9	23.1	9.9	28.0	7.4	6.0	8.2	0.7	9.7
Guillotine shear	39.7	109	707	0.9	22.2	13.9	25.9	8.3	8.3	12.0	0.9	7.4
Fork lift	76.1	1,348	8,741	2.8	45.1	26.7	9.3	3.3	2.6	2.5	0.2	7.4
Turnings crusher	13.0	38	246	0.0	27.0	10.8	37.8	5.4	2.7	2.7	0.0	13.5
Incinerator	17.0	45	292	2.2	18.2	15.9	25.0	6.8	9.1	6.8	0.0	15.9
Truck	93.5	1,982	12,853	8.8	21.1	8.1	31.7	8.1	5.4	6.1	1.3	9.4
Crane	86.2	855	5,545	3.7	24.0	12.5	28.2	7.0	7.6	7.9	0.2	9.0
Car flattener	6.1	15	97	7.1	7.1	7.1	35.7	14.3	14.3	7.1	0.0	7.1
Briquetter	19.8	64	415	7.9	19.0	6.3	38.1	9.5	1.6	9.5	0.0	7.9
Furnace	19.4	73	473	7.4	5.9	14.7	23.5	16.2	11.7	7.4	0.0	13.2
Magnet	82.6	777	5,039	3.3	25.0	10.7	31.3	6.9	6.5	6.1	0.1	10.1

(1) Based on projection of the 15.4 percent Extensive Survey sample.
(2) Actual figure - not projected.

Source: Extensive Survey of Ferrous Scrap Industry.

TABLE VI-13. RELATIONSHIP BETWEEN CAPITAL INVESTMENT AND TOTAL 1969 REVENUE, NUMBER OF EMPLOYEES, AND NUMBER OF HOURS OF WEEKLY OPERATION FOR IRON AND STEEL PROCESSORS

	Distribution of sample firms having capital investment as indicated (percent)						
	Distribution All Firms	Less Than $250,000	250,000 to 500,000	500,000 to 1 million	1 million to 2 million	2 million to 7 million	7 million to 10 million
Total 1969 Revenue ($)							
Less than 500,000	35.8	69.5	31.9	7.1	5.9	12.5	0.0
500,000 to 1 million	18.1	18.6	31.9	14.3	5.9	0.0	0.0
1 million to 3 "	27.9	10.2	31.9	52.4	58.8	25.0	50.0
3 " to 5 "	9.3	0.0	2.1	21.4	17.6	37.5	0.0
5 " to 7 "	3.7	1.7	2.1	0.0	5.9	0.0	0.0
7 " to 10 "	1.4	0.0	0.0	2.4	0.0	0.0	0.0
10 " to 15 "	2.3	0.0	0.0	0.0	5.9	25.0	50.0
Over 15 million	1.4	0.0	0.0	2.4	0.0	0.0	0.0
Number of Employees							
1 to 10	32.7	70.5	22.4	13.3	0.0	0.0	0.0
11 to 25	33.2	26.2	57.1	31.1	16.7	22.2	50.0
26 to 50	21.8	3.3	18.4	40.0	61.1	11.1	0.0
More than 50	12.4	0.0	2.0	15.6	22.2	66.7	50.0
Hours of Operation Per Week							
Less than 41	36.6	37.7	34.7	40.0	27.8	22.2	0.0
41 to 48	43.1	49.2	53.1	33.3	55.6	0.0	50.0
49 to 80	17.8	13.1	12.2	22.2	11.1	55.6	50.0
More than 80	2.5	0.0	0.0	4.4	5.6	22.2	0.0

Source: Extensive survey.

TABLE VI-14. AVERAGE CAPITAL INVESTMENT PER ESTABLISHMENT PER EMPLOYEE AND PER DOLLAR OF SALES CLASSIFIED BY REGION
(dollars)

	Average Capital Investment	Average Capital Investment Per Employee	Average Sales Revenue	Average Capital Investment Per Dollar of Sales
National	766,0000	23,946	2,032,000	0.37
New England	325,000	18,055	2,053,000	0.15
Middle Atlantic	642,000	20,709	1,787,000	0.35
South Atlantic	375,000	17,851	1,080,000	0.34
East North Central	1,091,000	38,964	1,922,000	0.56
East South Central	867,000	23,432	2,220,000	0.39
West North Central	1,026,000	38,000	1,692,000	0.60
West South Central	583,000	20,103	1,652,000	0.35
Mountain*	375,000*	46,875*	250,000*	1.50*
Pacific	1,138,000	27,095	4,287,000	0.26

* Sample consisted of only two firms.

Source: Extensive Survey.

Table VI-15 shows average age of processing equipment classified by region, total value of plant and equipment, and total revenue. As would be expected, the larger firms tend to have newer equipment. This is particularly noticeable in the classification by value of plant and equipment.

TABLE VI-15. AVERAGE AGE OF PROCESSING EQUIPMENT CLASSIFIED BY REGION, BY TOTAL CAPITAL INVESTMENT, AND BY TOTAL REVENUE

	Average Age (years)
Region	
New England	8.8
Middle Atlantic	10.5
South Atlantic	10.2
East North Central	9.2
East South Central	8.2
West North Central	9.8
West South Central	7.6
Mountain	11.3
Pacific	10.2
National Average	9.5
Total Capital Investment, dollars	
Less than 250,000	11.2
250,001 to 500,000	10.9
500,001 to 1,000,000	8.5
1,000,001 to 2,000,000	7.8
2,000,001 to 7,000,000	4.7
7,000,001 to 10,000,000	7.5
Over 10,000,000	--
Total Revenue, dollars	
Less than 500,000	11.7
500,001 to 1,000,000	9.0
1,000,001 to 3,000,000	9.2
3,000,001 to 5,000,000	8.1
5,000,001 to 7,000,000	5.8
7,000,001 to 10,000,000	7.5
10,000,001 to 15,000,000	7.5
Over 15,000,000	7.5

Source: Extensive Survey.

Problems Related to the Use of Capital Equipment. Three problems associated with the use of capital equipment are

(1) A general lack of knowhow in purchasing, installing, using, and maintaining equipment. This is particularly true of the smaller firms in the industry and is generally not a problem with many larger firms.

(2) The cost of equipment is often more than many firms can afford and the financing may be difficult if not impossible for some firms to obtain.

(3) Some processing equipment is simply not available or is inadequate to to do the job intended.

These problems are discussed further in Table VI-16 and solutions are proposed and discussed in Table VI-17.

TABLE VI-16. PROBLEMS RELATED TO THE USE OF CAPITAL EQUIPMENT

Problem Title	Lack of Know-How in Purchasing, Installing, Using, and Maintaining	Cost and Financing	Availability
Problem Definition	(1) Segment of scrap industry regards equipment as a necessary evil (2) Equipment purchase criteria may be irrational or defensive. (3) Industry in general not process or production oriented.	(1) Much of the required equipment is extremely expensive (over $50,000). (2) Difficult for small or medium size firms to obtain adequate financing.	(1) Equipment to perform some tasks is not available or if available is not adequate. (2) Equipment in many cases too inflexible for general use.
Effects of the Problem	(1) Operations not efficient. (2) Maintenance costs higher than need be. (3) Some purchased equipment not suited to do the job that is required. (4) Productivity lower than could be.	(1) Many firms do not buy equipment they require. (2) Firms tend to buy cheaper equipment than they should. (3) Industry is not as efficient as it could be. (4) Many firms must use old equipment that may be unreliable.	(1) Manual labor required but not available. 2) Unable to process some raw material economically.
Problem Analysis	(1) Lack of engineering type personnel in the industry. (2) Industry reluctant to seek out consulting engineering assistance with problems involving purchase, installation, and operation of equipment. (3) Little interchange of ideas among industry members. (4) Individual firms may purchase much equipment they do not need or which is not economical. (5) Mutual distrust may exist between scrap industry and the equipment manufacturers. (6) With better process and production know-how industry could economically recycle more scrap.	(1) Cyclical business history plus lack of firm market in future makes the securing of financing difficult. (2) Some firms have poor credit ratings or no credit rating at all. (3) Historical image of the industry sometimes leads to difficulty in arranging financing. (4) Many of the labor problems could be solved through replacement of man by machine.	(1) Some equipment is only applicable to large volume operations. (2) Market for scrap processing and handling equipment may not be large enough to attract research money for equipment development. (3) Scrap industry slow to adopt processing innovations. (4) Equipment or process innovation developed at the processor level is seldom shared with other processors. (5) If proper equipment was available at reasonable cost, more scrap could be recycled.

TABLE VI-17. RECOMMENDED SOLUTIONS ASSOCIATED WITH CAPITAL EQUIPMENT

Problem Title	Lack of Know-How for Buying, Using and Maintaining Equipment	Cost and Financing	Availability of Equipment
Recommended Actions	1. Education of the owners, users, and operators on the important aspects of equipment selection and utilization. 2. Encourage industry members to "share" their equipment problems and solutions with other members of the industry. 3. More cooperation between manufacturers and users of equipment.	1. Encourage development of equipment that will do the job for less of a capital outlay. 2. Develop a better industry image as a business. 3. Develop less expensive purchase plans.	1. Encourage research and development of needed equipment. 2. Coordination between scrap processors and manufacturers to translate needs into specific equipment, designs and developments.
Specific Actions	1. Initiate a program of equipment utilization seminars conducted by the manufacturers, consulting engineers, and experts from the scrap industry. (S) 2. Institute a formal procedure for compiling problem-solution case histories on process and equipment utilization. (S) 3. Recruit capable engineering personnel familiar with equipment and its operation on an industry wide basis. (S,I) 4. Organize and set up a consulting group available to members on a fee basis to assist with equipment and process planning and problems. (S)	1. Institute a "used" equipment sales service through ISIS, along with guarantee, etc. (S) 2. Investigate the feasibility of providing financing service of some form to individual firms. (S) 3. Investigate Government sponsored loan programs such as SBA. (S) 4. Release financial information--don't be secretive. (S,I) 5. Set up equipment leasing plans. (S,E) 6. Investigate long-term stable markets or contracts for supplying scrap. Contracts would make firm less of a financial risk. (S,I)	1. Underwrite equipment or process oriented research. (S) 2. Encourage processors to discuss innovations and processing limits. Become an industry. (S) 3. Convince equipment manufacturers that equipment is needed and that there is a market for it. (E,I) 4. Encourage industry utilization of new equipment and innovations. (S)

S - ISIS
I - Individual scrap processors
E - Equipment manufacturers

Iron and Steel Scrap Grades

The basic function of a ferrous scrap processor is the preparation and manufacture of iron and steel scrap, obtained from numerous sources and having a wide variety of physical and chemical characteristics, into products suitable for the iron and steel industries. The products are prepared, through the use of manual labor, increasingly sophisticated processing equipment, and exercise of quality control procedures, to specifications developed by the consumers, processors, and suppliers of ferrous scrap.

In general, the grade classifications developed are based either on source or size and density. Cleanliness, inclusion of off-grade materials, and residual content are also considered. Specifications have been developed for three basic areas: iron and steel scrap; alloy scrap, including stainless; and railroad scrap. These specifications appear as Appendix B of this report.

The greatest consumption of scrap by grade are the No. 1 products, which generally have the highest quality. These grades have maintained their share of the total scrap market, and undoubtedly will increase it somewhat in the future. Conversely, the No. 2 types, the products of obsolete scrap from potential ferrous solid waste, are showing a slight decline, even when shredded scrap is included. However, it is somewhat difficult to prove these conclusions statistically, as a significant portion, 20 percent, of total scrap consumption is classified as "all other". Scrap consumption by grades is shown in Table VI-18.

TABLE VI-18. SCRAP CONSUMPTION BY GRADE, SELECTED YEARS, 1960 To 1970

Grades	1960	1963	1965	1968	1969	1970
	Thousand Short Tons					
Carbon Steel						
Low phosphorous plate and punchings	3,702	3,219	4,560	1,887	2,042	1,849
Cut structural and plate	N.A. (1)	822	1,268	1,455	1,561	1,511
No. 1 heavy melting steel	21,490	25,181	30,355	27,018	27,195	26,501
No. 2 heavy melting steel	4,778	N.A.	N.A.	2,880	6,488	3,225
No. 1 and electric furnace bundles	5,462	6,439	7,131	7,420	7,632	6,024
No. 2 and all other bundles	3,984	5,896	5,735	4,056	4,270	3,917
Turnings and borings	N.A.	2,600	2,950	2,738	3,217	2,764
Slag scrap (Fe content)	N.A.	2,014	3,106	2,282	3,761	3,292
Shredded or fragmentized	N.A.	N.A.	N.A.	700	809	841
All other carbon steel scrap	17,372 (2)	11,666	14,496	16,803	17,863	17,437
Stainless steel	N.A.	719	840	878	1,189	783
Alloy steel	N.A.	2,627	3,354	2,949	3,295	2,838
Cast iron, including borings	9,680 (3)	13,307 (4)	16,390 (4)	14,123	14,395	13,045
Other grades of scrap	N.A.	130 (5)	174 (5)	871	1,099	1,159
TOTAL	66,469	74,621	90,359	87,060	94,816	85,188
	Percent of Total					
Carbon Steel						
Low phosphorous plate and punchings	5.6	4.3	5.0	2.2	2.2	2.2
Cut structural and plate	N.A.	1.1	1.4	1.7	1.6	1.8
No. 1 heavy melting steel	32.3	33.7	33.6	31.0	28.7	31.1
No. 2 heavy melting steel	7.2	N.A.	N.A.	3.3	6.8	3.8
No. 1 and electric furnace bundles	8.2	8.6	7.9	8.5	8.0	7.1
No. 2 and all other bundles	6.0	7.9	6.3	4.7	4.5	4.6
Turnings and borings	N.A.	3.5	3.3	3.1	3.4	3.2
Slag scrap (Fe content)	N.A.	2.7	3.4	2.6	4.0	3.9
Shredded or fragmentized	N.A.	N.A.	N.A.	0.8	0.9	1.0
All other carbon steel scrap	N.A.	15.6	16.0	19.3	18.8	20.5
Stainless steel	N.A.	1.0	0.9	1.0	1.3	0.9
Alloy Steel	N.A.	3.5	3.7	3.4	3.5	3.3
Cast iron, including borings	14.6	17.8	18.1	16.2	15.2	15.3
Other grades of scrap	N.A.	0.1	0.2	1.0	1.2	1.4
TOTAL	<100.0	<100.0	<100.0	100.0	100.0	100.0

(1) Not available.
(2) All other than grades shown, including alloy, stainless, and other grades of scrap.
(3) Exclusive of borings
(4) Borings: 1965 - 1,402, 1963 - 1,491.
(5) Steel car wheels.

Sources: Yearbook. Washington, Institute of Scrap Iron and Steel; Iron and steel scrap. In U.S. Bureau of Mines. Minerals yearbook. v.1. Washington, U.S. Government Printing Office.

Consumption by grade varies from industry to industry, depending on types of melting furnaces, operating practices, and final product requirements. For example, No. 1 heavy melting steel represents 35 percent of steel's requirements vs 2 percent and 10 percent of iron foundries and steel castings requirements, respectively (Table VI-19).

TABLE VI-19. SCRAP CONSUMPTION BY GRADE BY INDUSTRY, 1969

(Thousand Short Tons)

Grades	Total	Percent of Total	Manufacturers of Steel Ingots and Castings	Percent of Industry Total	Iron Foundries and Miscellaneous Users	Percent of Industry Total	Manufacturers of Steel Castings	Percent of Industry Total
Carbon Steel								
Low phosphorous plate, punchings	2,042	2.2	410	0.5	812	5.6	803	25.5
Cut structural and plate	1,561	1.6	360	0.5	964	6.6	215	6.8
No. 1 heavy melting steel	27,195	28.7	26,618	34.7	264	1.8	304	9.7
No. 2 heavy melting steel	6,488	6.8	6,284	8.2	196	1.4	3	0.1
No. 1 and electric furnace bundles	7,632	8.0	7,100	9.3	448	3.1	84	2.7
No. 2 and all other bundles	4,270	4.5	3,707	4.8	523	3.6	35	1.1
Turnings and borings	3,217	3.4	2,474	3.2	542	3.7	82	2.6
Slag scrap (Fe content)	3,761	4.0	3,731	4.9	26	0.2	4	0.1
Shredded or fragmentized	809	0.9	663	0.9	101	0.7	42	1.3
All other carbon steel scrap	17,863	18.8	15,279	19.9	1,698	11.7	914	29.0
Stainless steel	1,189	1.3	964	1.3	34	0.2	32	1.0
Alloy steel	3,295	3.5	3,024	3.9	127	0.9	139	4.4
Cast iron, including borings	14,395	15.2	5,652	7.4	8,302	57.2	332	10.5
Other grades of scrap	1,099	1.2	438	0.6	477	3.3	161	5.1
TOTAL	94,816	100.0	76,705	100.0	14,517	100.0	3,150	100.0

Source: Yearbook. Washington, Institute of Scrap Iron and Steel, 1970. p.38-40.

Sources of scrap in total are 60 percent home, 40 percent purchased. By grade, significant variations occur. Home scrap grades are typically No. 1 heavy melting, alloy scrap, all others carbon steel scrap, slag scrap, and cast iron. Purchased scrap, due to its prompt industrial and obsolete sources, is dominated by low phosphorous plate and punchings, cast structural and plate, bundles, turnings and borings, and shredded scrap. (Table VI-20).

TABLE VI-20. SCRAP SOURCES BY GRADE, PURCHASED VS PRODUCED, 1969
(Thousand Net Tons)

Grades	Purchased(1)	Produced	• Available Supply	Purchased as a Percent of Available Scrap
Carbon Steel				
Low phosphorous plate, punchings	1,739	286	2,025	85.9
Cut structural and plate	1,420	95	1,515	93.7
No. 1 heavy melting steel	6,054	20,442	26,946	22.5
No. 2 heavy melting steel	3,194	3,303	6,497	49.2
No. 1 and electric furnace bundles	5,917	1,459	7,376	80.2
No. 2 and all other bundles	3,699	384	4,083	90.6
Turnings and borings	2,604	497	3,101	84.0
Slag scrap (Fe content)	1,267	2,474	3,741	33.9
Shredded or fragmentized	799	---	799	100.0
All other carbon steel scrap	4,029	13,417	17,446	23.1
Stainless steel	454	724	1,178	38.5
Alloy steel	557	2,771	3,328	16.7
Cast Iron, including borings	4,736	9,806	14,542	32.6
Other grades of scrap	460	629	1,089	42.2
TOTAL	36,929	56,287	93,216	39.6

(1) Receipts - Shipments.

Source: U.S. Department of Interior, Bureau of Mines, Minerals Yearbook, "Iron and Steel Scrap," 1969, p 610.

The realtive importance of the varicus grades to the ferrous scrap industry is shown in Table VI-21. In general, the export market consumes a greater proportion of obsolescent scrap than do domestic markets.

TABLE VI-21. TOTAL PURCHASED SCRAP BY GRADE
(Thousand Net Tons and Percent)

Grades	Domestic	Percent	Export	Percent	Total	Percent
Carbon Steel						
Low phosphorous plate and punchings	1,739	4.7	N.A.	---	1,739	3.8
Cut structural and plate	1,420	3.8	N.A.	---	1,430	3.1
No. 1 heavy melting steel	6,054	16.4	3,452	38.2	9,506	20.7
No. 2 heavy melting steel	3,194	8.6	1,009	11.2	4,203	9.1
No. 1 and electric furnace bundles	5,917	16.0	593	6.6	6,510	14.2
No. 2 and all other bundles	3,699	10.0	1,038	11.5	4,737	10.3
Turnings and borings	2,604	7.1	767	8.5	3,371	7.3
Slag scrap (Fe content)	1,267	3.4	N.A.	---	1,267	2.8
Shredded or fragmentized	799	2.2	N.A.(1)	---	799	1.7
All other carbon steel scrap	4,029	10.9	1,474(2)	16.3	5,503	12.0
Stainless steel	454	1.2	76	0.8	530	1.1
Alloy steel	557	1.5	N.A.	---	557	1.2
Cast iron, including borings	4,736	12.8	627	6.9	5,363	11.7
Other grades of scrap	460	1.2	N.A.	---	460	1.0
TOTAL	36,929	100.0	9,036(3)	100.0	45,965	100.0

(1) Shredded scrap statistics were not available prior to 1970. However, in that year, shredded exports accounted for 1.2 million tons, 11 percent of total exports.

(2) All other scrap, including tin plate and terne plate.

(3) Exclusive of "rerolling material" - 254 tons.

Source: Domestic - Table VI-20; Export - ISIS Yearbook, 1970, p 46.

Specialty Areas

Stainless and Alloy Steels

The analysis throughout this report has generally considered steel as a whole, without regard to grade. Basically, the problems and opportunities affecting increased recycling are the same. However, some distinctions should be made.

Of the total steel shipped in the United States annually, about 91 percent is carbon steels, 8 percent alloy steels, and 1 percent stainless steels (Table VI-22). Stainless and alloy steels, while relatively low in tonnage, are high in value. And while domestic consumption of these products has been increasing, imports have taken the major share, estimated currently at over 20 percent of stainless steel supply.

TABLE VI-22. STEEL SHIPMENTS BY GRADE FOR SELECTED YEARS (percent)

Year	Carbon	Alloy	Stainless
1950	92.8	6.6	0.6
1955	92.6	6.6	0.8
1960	93.0	6.2	0.8
1965	90.8	8.3	0.9
1966	90.1	8.9	1.0
1967	90.6	8.4	1.0
1968	90.6	8.5	0.9
1969	90.6	8.4	1.0
1970	91.6	7.6	0.8

Source: Annual statistical reports. New York, American Iron and Steel Institute.

Stainless and alloy steel production by grade appears in Tables VI-23 and VI-24. Scrap is a major raw material input to stainless and alloy steels. All stainless steel is produced in electric furnaces, some in induction; alloy

TABLE VI-23. MAJOR STAINLESS STEEL GRADES, 1970 PRODUCTION

Grades	Percent
304	30.0
430	8.8
301	6.4
316	5.3
304L	3.8
201	3.5
410	4.0
All other - 300 series	10.3
All other - 400 series	6.1
Other chromium nickel stainless steels	4.8
501, 502, and all other high chromium heat resistant steels	2.9
All others	14.1
TOTAL	100.0

Note: The principal alloy elements in the 200 and 300 series are chromium and nickel; in the 400 and 500 series, chromium.

Source: Form AIS-7A. New York, American Iron and Steel Institute.

TABLE VI-24. MAJOR ALLOY STEEL GRADES, 1970 PRODUCTION

Grade	Percent
High strength, low alloy steels	26.5
Nickel-chromium-molybdenum	12.2
Chromium-molybdenum	12.0
Silicon sheet steel	10.4
Chromium	9.5
Molybdenum	6.6
Manganese	5.1
Nickel-molybdenum	1.5
Manganese-molybdenum	1.4
Chromium-molybdenum-vanadium	1.3
All other	13.5
TOTAL	100.0

Source: Form 104. New York, American Iron and Steel Institute.

production in 1970 was divided: electric furnaces - 36.8 percent; basic oxygen furnaces - 34.6 percent; and open hearths - 28.5 percent. Because of the high value of the steels produced by costly processing and alloy addition, the scrap used requires special care in preparation, selection, and segregation.

Many scrap firms handle all types of ferrous scrap; in the Extensive Survey, 74 percent of all firms shipped some stainless, 37 percent shipped some alloy. However, a specialized segment of the industry has evolved which concerns itself primarily with the processing and marketing of scrap products of high value. The major market for these specialists is the steel industry, which consumes over 90 percent of their products, with the remainder split evenly between iron and steel foundries.

Stainless and alloy scrap account for less than 5 percent of total iron and steel scrap consumption; for stainless, 38.5 percent of the available supply is purchased while with alloy, only 16.7 percent of that consumed is purchased. (See Table VI-20.) In the case of alloy, segregation is particularly difficult, a basic reason for the relatively low amount of purchased scrap usage. In addition, mill yields are significantly lower with alloy and stainless steels versus carbon steels; as a result, the amount of home scrap generated significantly reduces the purchased requirements.

With the exceptions of when stainless or alloy steels make up the major portion of obsolete products, most purchased stainless and alloy scrap comes from prompt industrial sources. Where they compose minor parts of obsolete products, such as with automotive trim and fasteners, their value is lost and is recycled only with lower grade materials.

The major characteristic which distingishes the processor of alloy and stainless steel scrap from others in the industry is the vital importance placed on the chemistry of the scrap. Alloy and stainless steel scrap command a premium over lower grades since they already contain the alloys required for meeting the specifications of alloy and stainless steel products, in a form and cost greatly reduced over primary addition agents except during nickel shortages. But the specialty steel business is specification sensitive. No chances can be taken with an expensive "off-analysis" heat caused by contaminated scrap. As a result, more costly handling, segregation, processing, and testing techniques are required in stainless and alloy processing. Sample lots are often melted to determine their chemical composition. Spectrographic and X-ray methods are used. The scrap is generally sold with a guaranteed analysis. Stainless and alloy scrap specifications are shown in Appendix B.

Another unique characteristic of stainless processing is the melting of scrap into specification ingots, sold with a guaranteed analysis and at a premium price. Because of its high value, this additional processing is possible, which up to now has not been the case with carbon steel scrap.

In general, the problems and obstacles to increased recycling of stainless and alloy materials contained in ferrous solid waste are not significantly different than those faced by all ferrous solid waste. Two differences do, however, occur. The demand is greatly affected by significantly higher imports of stainless steel; that produced abroad for U.S. consumption directly affects recycling of stainless scrap in this country. In addition, despite the favorable economics of stainless scrap consumption, producers often favor primary nickel for their nickel content rather than obtaining it from the stainless scrap. This is caused by a general feeling that it is easier to get the nickel requirements in this manner and also so that adequate nickel supplies can be obtained during nickel shortages from the primary producers. A change to stainless scrap from primary nickel for the nickel requirement could substantially increase the total stainless scrap usage.

A major factor which could increase stainless scrap usage in the future is the recent introduction of argon-oxygen melting. This technique allows the decarburization of a stainless steel melt without the loss of chromium. Thus, stainless steel scrap technically could be used as the total charge.

Railroad Car Dismantling

A significant source of iron and steel scrap, estimated at 3 million tons annually, comes from railroad equipment dismantling. Some decrease has occurred in recent years, but railroads remain a major source of obsolete scrap (Table VI-25).

TABLE VI-25. RAILROAD SCRAP SALES
(net tons)

Year	Scrap Sales	Locomotives, Freight and Passenger Cars	Total R.R. Scrap Sales
1955	2,235,955	1,826,533	4,062,488
1956	3,610,085	700,528	4,310,613
1957	2,422,171	396,450	3,109,283
1958	2,588,669	503,253	3,091,922
1959	3,000,761	32,333	3,033,094
1960	2,497,091	840,688	3,337,779
1961	2,294,210	744,521	3,041,731
1962	2,285,420	625,646	2,911,066
1963	2,294,428	638,061	2,932,489
1964	2,399,942	801,650	3,201,592
1965	2,057,936	845,321	2,903,257
1966	2,095,788	782,429	2,878,217
1967	1,754,039	709,765	2,463,804
1968	2,053,651	708,592	2,762,243
1969	1,805,930	797,113	2,603,043

Source: Yearbook. Washington, Institute of Scrap Iron and Steel, 1970. p.45.

Two major sources of rail scrap exist: rails and retired equipment. In 1969, 1,600 locomotive units, 81,000 freight cars and 2,900 passenger-train cars were retired from service. Retirement of locomotive and passenger equipment has shown an increase over the past ten years, while retirement of freight equipment has somewhat decreased (Table VI-26).

TABLE VI-26. EQUIPMENT RETIRED

	Locomotive units	Freight cars*	Passenger-train cars
1948	2,218	86,291	1,368
1949	4,046	100,848	1,818
1950	3,412	81,200	1,327
1951	3,972	58,644	1,154
1952	5,762	66,412	1,596
1953	4,501	63,320	1,829
1954	3,271	78,482	2,135
1955	2,562	82,321	1,319
1956	2,006	52,586	2,133
1957	1,210	57,544	1,773
1958	1,162	69,826	1,671
1959	963	96,574	1,892
1960	863	73,117	2,044
1961	555	94,240	1,820
1962	963	94,302	1,497
1963	1,026	84,494	1,350
1964	1,220	100,916	2,061
1965	1,634	77,700	2,382
1966	1,355	80,016	1,480
1967	1,308	104,032	1,574
1968	1,293	90,574	3,329
1969 Est.	1,596	81,341	2,868

Source: Yearbook of railroad facts. Washington, Association of American Railroads, 1970. p.71.

A substantial portion of this equipment is dismantled each year for salvage of reusable parts and obtaining iron and steel scrap. Over half of the equipment is dismantled by "captive" railroad yards, with the remainder handled by scrap processors who specialize in railroad scrap. About 30 firms, operating some 50 years make up this part of the scrap industry, and are naturally located in major rail centers. In general, the railroad scrap specialty is only part of the firm's total business. The yards act as disposal points for major railroads and railroad fleet owners. Railroads are the major source of cars for demolition, as well as the prime customer for salvaged parts, such as couplers, yokes, and draft gears. These parts are purchased both as an inventory of reusable components and for reworking for installation in rebuilt cars. A cross section of typical scrap processing yards which handle railroad scrap appears in Table VI-27.

TABLE VI-27. SUMMARY OF SURVEY OF OPERATIONS, PLANT, AND EQUIPMENT AT 15 TYPICAL SCRAP PROCESSING YARDS THAT DISMANTLE RAILROAD CARS

	Total for 15 yards	Arithmetic average for 15 yards	*Range of observations*			
			Smallest value	Lower interquartile	Upper interquartile	Greatest value
1. Dollar volume:						
Estimated annual gross, scrap and salvage, all sources	$27,600,000	$1,840,000	$600,000	$1,000,000	$2,900,000	$5,000,000
Percentage attributable to railroad car operations	44	44	5	15	80	95
Estimated gross from railroad car scrap (salvage excluded)	$10,344,000	$689,000	$28,000	$300,000	$900,000	$2,100,000
2. Physical car operations:						
Number of railroad cars annually	21,840	1,460	50	700	2,000	4,000
Tons of scrap steel recovered from railroad cars	376,000	25,000	1,000	11,000	32,000	75,000
Average tons recovered per car	17	17	12	15	20	20
3. Yard characteristics:						
Value of yard and fixed improvement to realty	*$8,000,000	*$778,000	$300,000	$400,000	$900,000	$3,000,000
Number of acres at sites	246	16	3	7	20	54
Average value per acre	*$42,000	*$42,000	$9,300	$30,000	$68,000	$111,000
4. Equipment inventory:						
Number of major items of processing equipment available:						
Magnetic lifts and grapples	99	7	None	3	5	12
Cranes	59	4	1	3	4	12
Shears	29	2	None	None	4	12
Conveyors	14	1	None	None	2	4
Wheelpresses	10	1	None	1	1	1
Feeders and rams	8	....	None	None	1	4
Scrap breakers	4	....	None	None	1	2
Incinerators	3	....	None	None	None	2
Other (Including Balers(2), Hammermills(1), Magnetic separators(2), and Shredders(1) but excluding containers and transporters)	6	....	None	None	1	3

* Based on 9 reporting yards.

Source: Butler, D. M., and W. M. Graham. Dismantling railroad freight cars. Public Health Service Publication No. 1850. Washington, U.S. Government Printing Office, 1969. p.13.

Average freight car life is 35 years. Types of freight cars, the major source of railroad scrap, in service and retirement are shown in Tables VI-28 and VI-29.

TABLE VI-28. FREIGHT EQUIPMENT IN SERVICE, 1970.

Type	Total	Class I railroads	Other railroads	Car companies and shippers
Box cars:				
Plain	375,668	367,833	7,653	182
Equipped	171,237	168,528	1,668	1,041
Covered hoppers	170,742	130,954	816	38,972
Flat cars	128,359	75,622	1,095	51,642
Refrigerator cars	116,026	53,813	1,465	60,748
Stock cars	10,477	10,189	—	288
Gondola cars	196,231	187,429	5,929	2,873
Hopper cars	399,498	388,492	8,385	2,621
Tank cars	174,749	4,021	85	170,643
Other freight cars	39,035	36,462	1,110	1,463
Total	1,782,022	1,423,343	28,206	330,473

Source: Yearbook of railroad facts. Washington, Association of American Railroads, 1971. p.51.

TABLE VI-29. FREIGHT CAR RETIREMENT BY TYPE,
Twelve Months ending July 31, 1967

Boxcars	35,272
Covered hoppers	1,242
Gondolas	14,401
Hopper cars	17,758
Flat cars	1,263
Refrigerator cars	4,254
Other	2,801

Source: Traffic World, 131(8) Aug. 1967.

The proportion of cars retired by type is reasonably consistent from year to year, although the total number may vary significantly.

It has been estimated that over the long term, an average of 50 to 60 thousand cars a year is the highest sustainable rate at which freight cars will be retired.(1) The size of the fleet is gradually being reduced in number, although the cars being added are larger and have higher capacity, and subsequently their average capacity is 81 tons versus 61 tons for cars being retired.(2)

Average car capacity in 1960 was 55.4 tons versus 67.2 in 1970, while average freight carload increased from 1960's 44.4 tons to 54.6 tons in 1970. Average car utilization increased from 1960's 954 ton miles per freight car day to 1,418 in 1970 (Tables VI-30, VI-31, and VI-32).

TABLE VI-30. FREIGHT CAR CAPACITY (average)

	Tons
1929	46.3
1932	47.0
1939	49.7
1944	50.8
1947	51.5
1951	52.9
1954	53.7
1955	53.7
1956	54.0
1957	54.5
1958	54.8
1959	55.0
1960	55.4
1961	55.7
1962	56.3
1963	56.8
1964	58.3
1965	59.7
1966	61.4
1967	63.4
1968	64.3
1969	65.8
1970 Est.	67.2

TABLE VI-31. FREIGHT CARLOAD (average)

	Tons
1929	35.4
1939	36.8
1944	40.3
1947	41.0
1951	42.0
1955	42.4
1956	43.1
1957	43.8
1958	43.5
1959	43.5
1960	44.4
1961	44.9
1962	45.4
1963	46.7
1964	47.8
1965	48.9
1966	50.1
1967	51.1
1968	51.8
1969	53.1
1970 Est.	54.6

TABLE VI-32. TON MILES/ FREIGHT CAR DAY (average

	Tons
1929	582
1939	610
1944	1,113
1947	1,057
1951	1,028
1955	1,000
1956	1,023
1957	975
1958	882
1959	950
1960	954
1961	966
1962	1,041
1963	1,113
1964	1,160
1965	1,251
1966	1,310
1967	1,371
1968 Rev.	1,350
1969 Rev.	1,416
1970	1,418

Source: Yearbook of railroad facts. Washington, Association of American Railroads, 1971. p.44, 49, 52.

Nearly half the cars being retired are gondolas, hoppers and tanks. These types present no unusual problems for the processor. But the other half, using wood as an integral part of their strucutre, as well as the insulative materials used in refrigeration cars, cause problems. The high cost of manual removal, together with increased open burning restrictions as a means of disposal, have become a serious problem.

Railroad scrap is generally a preferred scrap type, due to its homogeneous nature, although increasing utilization of high-strength - low alloy steels can cause problems due to their undesirable residuals. It is usually designated as No. 1 Heavy Melting Steel. However, a number of types of railroad scrap exist, as indicated by the specifications of the Association of American Railroads appearing in Appendix B.

Railroad car dismantling typically consists of: delivery to scrapping area, body removal, truck parts salvage, wood separation (when required), body parts salvage, metal processing, scrap sorting and loading, and scrap delivery to mills. Wood removal is by hand where open burning is prohibited. Torches and shears are the primary size reduction equipment; secondary size reduction (where required) is accomplished by shredders, rippers, pulverizers, hammermills, and ball mills; and compaction (where required) is done by balers or "squeeze boxes." All of this equipment is used for other types of scrap processing as well, although the larger size of railroad equipment to be processed presents special considerations and problems.

The sale of salvage parts is normally the profit opportunity for the operation, as purchase of cars and processing costs often more than offset the sale of scrap. This leads the rail dismantler to concentrate on equipment where wood removal and disposal is not a concern. The salvage and scrap components of box cars are shown in Table VI-33.

TABLE VI-33. THE SALVAGE AND SCRAP COMPONENTS OF TYPICAL BOXCARS BEING RETIRED

	Boxcar rated capacity		
	40 tons	50 tons	70 tons
Total metallic (tons)	17-20	20-21	24
Trucks (2) (tons)	6	7	8.5
Typical salvage (tons)	1.5	1.5	1.5
Net ferrous scrap (tons)	4.5	5.5	7
Body, including under frame (tons)	11-14	13-15	15.5
Typical salvage (including brake systems, couplers (2), yokes (2), draft gear (2), which yield about one ton of metal of which about half normally becomes salvage and half scrap)	0.5-1	0.5-1	0.5-1
Net ferrous scrap (tons)	10-13.5	12-14.5	14.5-15
Typical salvage-scrap distribution for total car:			
Salvage (tons)	2-3	2-3	2-3
Scrap (tons)	15-17	17-19	21-22

Source: Butler, D. M., and W. M. Graham. Dismantling railroad freight cars. Public Health Service Publication No. 1850. Washington, U.S. Government Printing Office, 1969. p.9.

A recent study was aimed at the problem of wood removal and disposal.(1) Within the constraints of keeping environmental pollution at acceptable levels and implementation without significant impairment to the economic viability of the overall scrapping process, it suggested two approaches: high-pressure water jet removal of wood, and disposal through hooded self-incineration. Research is being conducted on these approaches. Three applications for the removed wood were suggested as appropriate: use of wood in the form of chips for chip board or fireplace logs, the use of wood particles as fillers or carriers, and wood conversion to mulch. All, however, are outside the scope of present scrap yard operations, although further investigation of their economic viability would be desirable.

Demolition and Shipbreaking

Two allied, yet separate, highly specialized areas of the ferrous scrap industry are building and industrial plant demolition and shipbreaking. Characteristic of both is the sophisticated advanced engineering planning required to achieve progressive recovery of materials without loss of time. Both are considered as "construction in reverse."

With increasing urban renewal and new plant and equipment construction, the business of building wrecking and industrial demolition offers a significant source of ferrous scrap. A significant amount of this activity is conducted by firms not closely allied with scrap processors; however, major dismantling operations are also conducted by divisions of major scrap processors. Dismantling is a highly specialized activity, requiring large investments in capital equipment and engineering talent.

These specialized firms bid against each other to obtain demolition rights. The bids are based on two major factors: the cost of the actual demolition and the value of the resultant materials. In building wrecking, the cost of dismantling is generally higher than the value of the resultant salvageable materials. In industrial plant demolition, the reverse is generally true.

The ferrous materials are generally trucked to a scrap yard for handling as is any other ferrous scrap product. Structural steel components are the major ferrous items. In metropolitan areas, there are numerous specialty salvage dealers, who purchase from the dismantler the nonferrous materials, such as lumber, plumbing and electrical fixtures, doors, and other building components of value; the same is true of obsolescent equipment with resale value in industrial plant demolition. However, significant amounts of nonmarketable materials are generated, particularly in building wreckings, such as concrete, unsalvageable wood, glass, and other construction materials. These materials must be disposed of by the dismantling contractor.

Shipbreaking is the other specialized function in this area, and a prime source of ferrous scrap. As with most industrial plant demolition, the high bid will get the contract, as opposed to building wrecking where the low bid prevails. Obsolete ships are a prime source of ferrous scrap, with plates and structural shapes being the major items. Shipbreaking activity is carried on in or near coastal ports, and generally by firms closely allied with scrap processors. In contrast to demolition, significant competition is encountered with foreign shipbreaking firms, depending on the foreign ferrous scrap demand.

The same factors as with demolition are considered in bid preparation, i.e., cost of scrapping and value of resultant materials. Metallic content is based on the ship's displacement, from which the nonmetallic materials such as fuel oil, water, furnishings, concrete, wood, and other materials, are deducted. Again, a market exists for some of these nonferrous materials, but in general, it is the value of the ferrous scrap materials and marketable equipment which provides the pay-off to the shipbreaker.

In summary, both specialty areas are prime sources of ferrous scrap. Each requires a high degree of engineering planning and skills, and significant investment in capital equipment. The primary economic factors involved are the costs of dismantling, segregating, and preparing the resultant materials for marketing, the efficient timing of the operation, and the actual marketing of the salvageable materials.

Problems of the Ferrous Scrap Industry

The ferrous scrap industry, like most other industries in the United States, has numerous problems as well as opportunities. Some directly effect increased recycling, others only indirectly, and a few have no effect. The major problems faced are:

- Low Demand for its Products. This problem has without question the greatest effect on the ferrous scrap industry and increased recycling of ferrous solid waste. The reasons why and what can be done about them are detailed throughout this report, and in the Summary. Major among them are the low growth rate of consuming markets, changing iron and steelmaking technology, reduced requirements for purchased iron and steel scrap of total scrap consumption, and recycling economics.

- Lack of Continuous and Steady Market for its Products. This situation caused basically by the cyclical nature of its markets, is another major problem faced by the scrap industry. With increasing capital investment requirements, a steady throughput of material is required for profitable operation. Operating inefficiences, both from equipment and labor viewpoints, also occur. With the current cyclical nature of its markets, the flow of scrap is turned on and off like a faucet, with its greatest effect on obsolete scrap movement and undesirable price volatility.
- Increasing Costs of Doing Business. The scrap industry is little different than other industries in this respect. Increasing equipment costs, inventory holding costs, wages and salaries, rents, transportation costs, insurance, taxes, and other costs of doing business have increased dramatically for the scrap industry in recent years. Many of these are of a "fixed nature", and therefore the cost of scrap processing has risen substantially; the processor's "breakeven" has greatly increased. As a result, if scrap prices are at low levels, the cost of handling and processing alone prohibits movement or purchase by the processor, with its greatest effect on obsolescent scrap movement. Industrial accounts must continue to be serviced, regardless of price; otherwise a prime source of material will be lost to competition. But even this conceivably could change if industrial accounts obtain lower and lower values for their scrap. This in turn would increase the cost of his prime product to the consumer, as scrap value is considered in determining net material costs and ultimate selling price of the finished product.

- Increasing Transportation Problems and Costs. This area is of increasing concern for scrap processors and the movement of ferrous solid waste. A separate section of this report, beginning on page 289 has been devoted to this area. Increasing costs have reduced the radius of scrap movement; unavailability of appropriate transportation carriers and service is another problem; apparent discriminatory rates is still a third.

- Increasing Equipment Costs and Problems. This area, like transportation, has also had a separate section of this report devoted to it, beginning on page 182. The major problems involve lack of know-how in purchasing installing, using, and maintaining, cost and financing, and availability of appropriate equipment for the smaller and medium-sized processor.

- Legal Constraints. A separate section of this report has also been devoted to the governmental influence on recycling and solid waste utilization, beginning on page 298. The major problems are in the areas of discriminatory classification, licensing, and restrictions on scrap processors, depletion allowances for competitive materials and pollution codes.

- Increasing Complexity of Materials and Consumer Goods. The wider use of a variety of materials and higher alloy iron and steels makes separation and preparation of these potential sources of iron and steel scrap into products suitable for the higher quality demands of scrap markets increasingly difficult.

- Labor and Management. Labor is a significant problem area for the scrap processor. In the Extensive Survey, it was the number one problem cited in response to "what is the most serious problem facing you as a businessman in the scrap industry?". While increasing mechanization is taking place, requiring skilled equipment operators, many jobs in a scrap processing yard are carried out by unskilled or semi-skilled workers. Materials handling, hand sorting and cutting, and other common labor jobs, while vital to the effective functioning of a yard, reflect in their wage rates the skills, or lack thereof, required.

While a great number of the larger yards in the North and West are unionized, a significant number of firms in the South and smaller yards throughout the nation employ nonunion labor. Numerous long-term employees of yards exist in the scrap industry, but in general, the turnover is quite high. In times of high employment, wage rates for such jobs reflect demand to a somewhat greater extent than in other industries, leading to high turnover and unavailability of competent labor for the processor. In times of unemployment, wage rates again are sensitive to the lack of demand, and as a result approach parity with "welfare-type" payments, offering little incentive for working in a scrap yard. Since most establishments employ relatively few in total, turnover is particularly critical. Based on the Extensive Survey, over 65 percent of the establishment employ less than 25 people; 33 percent employ 10 or less; 29 employees per establishment is the national average.

Scrap yard work is generally conducted outside, causing labor problems in extremely cold or hot periods of the year. Working conditions, while improving through the efforts of individual firms and the Institute, are still subject to extensive safety precautions.

Like other small, family owned and operated firms, the opportunity for advancement for outsiders is limited. All these factors add up to increasing labor problems for the scrap processor in terms of cost, availability, and quality.

Management is another area of concern, particularly for the small- and medium-sized processor. The scrap processing industry is becoming increasingly sophisticated, requiring somewhat different skills than those traditionally used. No longer is trading the only commercial objective; the products must be marketed. While the major scrap processors have made significant strides toward newer management skills and techniques, a large number of firms still operate as in the "good old days". Technical expertise is generally lacking, not in the processing of scrap, but in the metallurgical knowledge required for marketing that scrap to the consuming markets, to the best advantage of both processor and consumer.

On-the-job training programs for the hardcore unemployed funded by the U.S. Department of Labor and other labor and management training programs conducted by ISIS and participating firms are making progress in certain of these areas, but many problems remain.

- Lack of Public Awareness of the Scrap Processor's Role in Recycling.

The scrap industry suffers from considerable public misunderstanding of its role in our society. The industry's public image, while improving, is still less than desirable. Members are still often thought of as junk collectors who serve no useful purpose other than their own. The vital role performed by the scrap industry in cleaning up our environment and providing conservation of our natural resources is not generally known. The manifestation of this attitute can be noted in the frequent bypassing of the industry in environmental decision-making. Examples include such areas as restrictions which apply to processors, as well as junk collectors or auto wreckers, or with classification and its tax and other implications as they apply to wholesale trade, rather than manufacturing, the business of the scrap processor. Without the scrap processing industry, natural resource depletion would be greatly increased for iron ore and coal; solid waste accumulation would significantly increase, bringing with it increased costs of disposal and blight on our landscape and in our cities. The processor's role is vital, and while he must merit recognition as such, is often misunderstood.

Problems as Seen by Industry Members

In conclusion, Tables VI-34 and VI-35 indicate the problems of the industry as seen by the individual members themselves in response to the Extensive Survey questions of "What is the most serious problem you face as a businessman," and "What is the most serious problem facing the scrap industry?"

TABLE VI-34. MOST SERIOUS PROBLEM FACING THE INDIVIDUAL ESTABLISHMENT

Problem	Percent of Establishments Ranking Problem As #1
Labor availability and costs	45.9
Market and steel technology	15.9
Governmental restrictions	11.8
Operating problems, including equipment costs	8.9
Profits and prices	7.3

Source: Extensive Survey.

TABLE VI-35. MOST SERIOUS PROBLEM FACING THE INDUSTRY

Problem	Percent of Firms Ranking as #1 Problem
Market and steel technology	22.1
Labor availability and costs	21.3
Governmental restrictions	14.8
Operating problems, including equipment costs	8.6
Profit and prices	8.6
Transportation	5.7

Source: Ibid.

Residue Disposal

An increasing cost and problem for the scrap processor is the disposal of nonmarketable solid waste. An increasing amount of nonmarketable residue is caused by a lack of markets, the inclusion of increasing nonferrous materials in consumer goods and tighter burning restrictions. In the Auto Wrecker section of this report, the components of their residue is noted. For scrap processors, the Extensive Survey gives valuable insight to the types and methods of solid waste disposal as shown in Tables VI-36 and VI-37. Minor regional differences were indicated.

TABLE VI-36. TYPES OF NONMARKETABLE SOLID WASTE GENERATED

Type	Percent of Establishments Generating and Feeling It's a Problem
Garbage and/or trash, dirt	57.2
Rubber	20.6
Wood	13.3
Paper	5.6
Glass	1.7

Source: Ibid.

TABLE VI-37. METHOD OF DISPOSAL - NONMARKETABLE SOLID WASTE

Method of Disposal	Companies Using Method, percent
Haul to dump or other public disposal	84.4
Burn, incinerate	6.6
Contracted out	3.6
Self-disposal on property	3.0

Source: Ibid.

REFERENCES--Chapter VI

1. Butler, D. M., and W. M. Graham. Dismantling railroad freight cars; a study of improved methods with application to other demolition problems. Public Health Service Publication No. 1850. Washington, U.S. Government Printing Office, 1969. 32 p.
2. [Yearbook of railroad facts. Washington, Association of American Railroads, 1971. p. 52.]

CHAPTER VII
THE AUTO WRECKING INDUSTRY

This industry, as previously noted, is the main channel through which obsolescent motor vehicles flow to the scrap processor. It is therefore the major source of obsolescent scrap for the scrap processor, since it is estimated that 35 percent of the total obsolescent scrap processed is old vehicles. However the industry's primary business is the obtaining of discarded vehicles, stripping them of their useful parts, and selling those parts. Disposing of scrap metal residue, i.e., auto hulks, is of secondary importance.

The industry comprises about 15,600 companies, with 98,500 employees, and has annual sales of salvaged parts and scrap metal in excess of $5 billion. Geographic distribution of companies generally follows population trends. The majority of companies are small, with 70 percent employing 5 or less; slightly under 90 percent employ 10 or less.(1)

The industry makes a vital contribution to our economy by acting as a source of parts for older model vehicles and as a collection point for obsolescent vehicles prior to scrap processing. In general, a firm disposes of hulks in any given year at about the same rate as acquired. His sources of vehicles are: individuals - 38 percent; vehicle dealers, new and used - 26 percent; insurance companies, auction pools - 21 percent; municipal pounds, state and local authorities - 12 percent; and other - 3 percent.(2) Very few are obtained at little or no cost; the average price paid is $275, ranging from $30 to $45 for low quality (few salvageable parts) to high quality late models around $400 to $435. Prices of over $500 are not unusual.(1)

Depending on the auto wrecker's type of operation, the vehicle after being received is either stripped of marketable parts which go to a parts inventory, or else the vehicle acts as its own "warehouse", with parts removed as sold. In either case, the final product ready for disposal is the vehicle hulk. At this point, the wrecker has two alternatives: movement of the hulk to a scrap processor, or retention in his inventory. The two basic factors affecting this decision are: market price the processor will pay for the hulk relative to disposal costs, and inventory space.

The wrecker has three basic choices in preparation of the hulks for shipment to scrap processors: (1) find a processor who will take as is, of which there are few opportunities, (2) burn the hulk to clean it, which practice is severely limited by increasing open burning restrictions, or (3) hand strip the vehicle of the objectionable residue, such as tires, gas tanks, upholstery, glass, and others. The latter is expensive, and due to the smallness of most wreckers, equipment costs to assist in stripping or incineration are prohibitive.

Another problem facing the auto wrecker in his disposal of hulks is transportation to the scrap processor. A typical price paid by a processor for a hulk is $10. With stripping preparation costs by the wrecker approximating $5/hulk, this leaves little margin for getting the hulk to the processor. As a result, over 75 percent of the hulks delivered to processors travel less than 50 miles.(1) This is a national average, and as can be seen in Table VII-1, is subject to regional differences. The major factors influencing this movement and its distance is price paid by processor and his proximity to wrecker.

TABLE VII-1. MOVEMENT OF JUNK VEHICLES TO DISPOSAL POINTS
(percent)

Region	0-10 Miles	10-49 Miles	50-100 Miles	101-200 Miles	Over 200 Miles	Total U.S. Vehicles Moved
New England	30.7	45.3	17.7	6.3	--	6.9
Middle Atlantic	39.3	44.5	12.0	4.2	---	27.2
East North Central	33.6	41.3	19.2	2.8	3.1	17.5
West North Central	46.4	14.2	9.3	12.7	17.4	10.8
South Atlantic	36.2	49.0	11.6	1.9	1.3	5.6
East South Central	34.8	29.6	25.0	8.4	2.2	7.5
West South Central	52.3	18.5	9.1	6.9	13.3	9.3
Mountain	29.9	28.3	13.7	5.9	22.0	6.3
Pacific	43.1	48.1	6.2	1.6	1.1	9.1
U.S. Average	38.9	36.7	13.6	5.3	5.4	100.0

Source: Derived from BDSA auto wrecking industry report. Scrap Age, 27(2):237, Feb. 1970.

The third major problem for the wrecking industry is disposal of unmarketable waste from operations. This waste material amounts to about 10 percent by weight of the total input to the operation. Actually, it is a small proportion of the total industrial solid waste generated annually--slightly over 1 million tons of the 110 million total (Table VII-2). But it is a highly visible problem, and is difficult to dispose of by conventional methods such as incineration or burial as landfill. Some research is being conducted in these areas, particularly regarding scrap tires.(3) But the situation is getting worse, as increased utilization of nonmetallics in vehicles occurs. For example, in 1960 the plastic content of a typical vehicle was 22 pounds; by 1971, this had increased to 110 pounds;(4) and is expected to approximate 200 pounds by 1980.(5)

TABLE VII-2. NATURE AND VOLUME OF SOLID WASTE CREATED BY AUTO WRECKING INDUSTRY IN 1968

Nature of Waste (1)	Pounds Per Vehicle	Long Tons (2)	Percent of Total
Rubber Tires	73 (3)	290,346	24.4
Other Rubber	32	129,042	10.9
Plastics	8	32,261	2.7
Glass	52 (4)	209,694	17.6
Other Materials (5)	131	528,269	44.4
Total	295	1,189,612	100.0

(1) Average analysis of 1963 4-door Chevrolet sedan; other vehicles will vary in waste content.

(2) Based on BDSA estimate of vehicles taken in by industry in 1968.

(3) Estimated on basis of four out of five tires junked per vehicle. Actual tonnage is probably somewhat higher due to greater weight of junked truck and bus tires.

(4) Estimated on basis of recovering 50 percent of all body glass.

(5) Dirt, oil, wood, miscellaneous trash, upholstery, etc.

Source: Estimated by BDSA on basis of Bureau of Mines analysis data. BDSA auto wrecking industry report. Scrap Age, 27(2):231, Feb. 1970.

A fourth problem of the wrecking industry is aesthetic in nature. While slightly over 70 percent of the yards surveyed have some type of screening, it is felt that much of the fencing is not adequate to meet zoning requirements,(1) nor is it visually attractive. Yard screening depends largely on three factors: zoning requirements, cost of construction, and need for physical protection. Location with regard to topography presents additional problems.

And the fifth problem while not necessarily one for the wrecker but for recycling, is the lack of sufficient economic inducement to move hulks from the wrecker's yard to the scrap processor. It has been estimated that 25-50 percent of vehicles in wrecking yards have little or no parts value,(6) and therefore are ready for recycling.

A simplified flow chart indicating location of these and other problems appears as Figure VII-1. Potential solutions are shown in Table VII-3.

FIGURE VII-1. VEHICLE FLOW WRECKING YARD

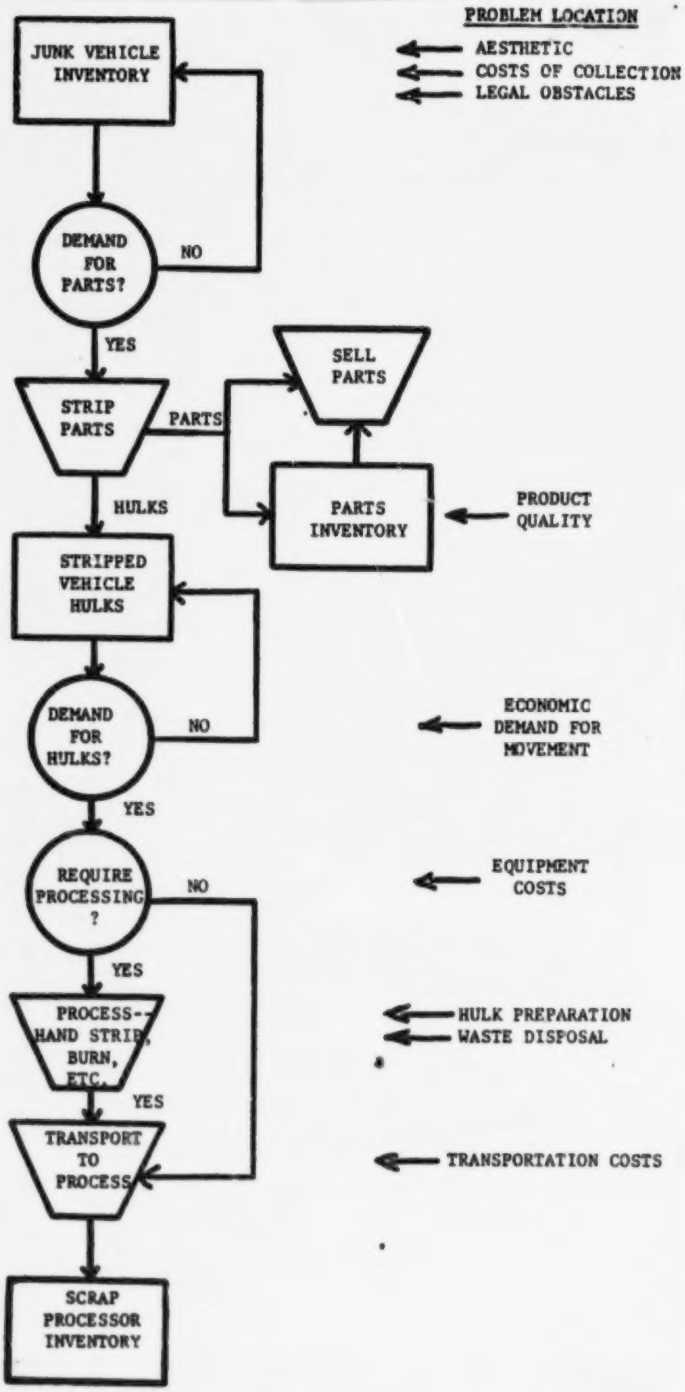

PROBLEM LOCATION
AESTHETIC
COSTS OF COLLECTION
LEGAL OBSTACLES
JUNK VEHICLE INVENTORY
DEMAND FOR PARTS?
NO
YES
STRIP PARTS
PARTS
SELL PARTS
PARTS INVENTORY
PRODUCT QUALITY
HULKS
STRIPPED VEHICLE HULKS
DEMAND FOR HULKS?
NO
ECONOMIC DEMAND FOR MOVEMENT
YES
REQUIRE PROCESSING ?
NO
EQUIPMENT COSTS
YES
PROCESS--HAND STRIP, BURN, ETC.
HULK PREPARATION
WASTE DISPOSAL
YES
TRANSPORT TO PROCESS
TRANSPORTATION COSTS
SCRAP PROCESSOR INVENTORY

TABLE VII-3. PROBLEMS —> SOLUTIONS, AUTO WRECKING INDUSTRY

Problems	Solutions	Action By
Equipment Costs	1. Research aimed at development of low cost equipment--incineration, stripping	G,W
	2. Loans/subsidies/tax relief for equipment purchases.	G
Transportation Costs	1. Equitable rates	G
	2. Preferential rates	G
	3. Development of improved transportation equipment, e.g., portable flatteners/shredder, special truck/rail equipment	E
	4. Development of improved transportation systems--short haul, centralized collection points.	W,G,S
Legal Obstacles	1. Uniform motor vehicle titling	G
	2. Streamlined administrative practices.	G
Product Quality	1. Parts warranty study.	W,G
Costs of Collection	1. Subsidize movement.	G
Demand for Hulks	1. Artificial demand stimuli	
	(a) "buy recycled" inventives	
	(b) "use recycled in production"	G
	2. Stockpiling of processed material	G
	3. Expanded research on increased utilization of hulks.	G,M
Waste Disposal	1. Expanded research on rubber and glass utilization/disposal.	G
Hulk Preparation	1. Lessen preparation requirements	S,M
	2. Centralized, high volume incinerators or other processing equipment.	S,W
Aesthetic	1. Increased uniform screening	W,S
	2. Subsidies/low cost loans if required	G
	3. Future facility increased zoning requirements	G

W - Wreckers
S - Scrap Processors
G - Government
E - Equipment manufacturer
M - Markets for scrap.

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CHAPTER VIII

TECHNOLOGY OF IRON AND STEEL SCRAP UTILIZATION

In this section, Battelle presents its appraisal of the present status and recent modifications and process developments in iron and steel technology as related to scrap utilization. The primary objective has been the definition of those aspects in which the increased use of iron and steel (ferrous) scrap may be developed in present processes and to speculate on new ideas concerning techniques and aspects of utilization that would appear to deserve consideration.

Some of the factors that are important in regard to past and future scrap utilization in the iron and steel industry may be summarized as follows:

(1) The recent positive stance of the Federal Government has provided both legislation and funding to promote increased utilization of ferrous scrap through the development of recycling technology.

(2) Large steel companies have captive iron ore and coke sources and/or long-range contractual commitments for ore and coke. Thus the necessary operation of large blast furnaces using the above raw materials to provide hot metal for steelmaking has precluded any substantial usage of scrap by large steel companies. This situation will prevail unless there are changes in corporate management philosophy or it can be clearly shown that new techniques will allow for increased scrap usage with economic advantages.

(3) International politics often play a part in decisions related to raw material sources and supply.

(4) The recent development of new steelmaking processes such as the BOF process and continuous casting have a direct and substantial impact on scrap utilization and "home" scrap generation.

(5) The presence of residual elements in ferrous scrap restricts the amount and grade of scrap that can be used. Although the scrap processors have made substantial progress in improving scrap quality with regard to residuals, further improvements must be made.

(6) In general, the iron and steel industry allocates little or none of its research funds on investigations related to increased scrap consumption.

(7) Most of the scrap processors are relatively small with limited financial resources; thus the funds necessary for substantial, broad and long-range research and development programs on ferrous scrap technology are not within their means.

(8) The cyclical nature of scrap pricing is an inherent and important factor in its utilization; steel plants logically prefer to have known and reliable costs for all of their raw materials.

The factor which is almost universally cited as the major problem in the increased use of processed scrap is the presence of dirt, nonmetallics and metallic impurities. This criticism, justified to a considerable extent, is directed mainly at No. 2 bundles and indicates that serious attention should be given to the conversion of this scrap (largely obsolete automobile and truck bodies) to some other form of substantially higher quality. Fragmentized or shredded scrap has been a step in the right direction but further improvement is necessary.

Scrap Quality

The quality factors which are most pertinent to ferrous scrap utilization are size and shape, bulk density, and the presence of metallic and nonmetallic impurities. A major part of the potential and actual scrap inventory consists of obsolete vehicles and appliances which have in the past been processed into scrap as No. 2 bundles of relatively poor quality both in terms of absolute quality and in consistency. The Battelle report of 1960(1) indicated that visual inspection is not a reliable criterion for No. 2 bundle quality and that the melting of a large sample and subsequent analysis would be most substantive as a quantitative guide in measuring and improving quality and in increasing purchased scrap usage. The results of melting individual bundles in the 1960 study gave the following values for composition:

Element	Range, percent	Average, percent
Fe	62-96	86
Cu	0.07-2.79	0.48
S	0.011-0.26	0.075
Sn	0.007-0.285	0.075
Ni	0.03-0.55	0.10
Cr	0.04-0.22	0.12
Mn	0.05-1.30	0.39

Due to attempts by processors to improve quality by incineration and stripping techniques, it is obvious that present quality is considerably improved over that of 1960, but No. 2 bundles still carry the stigma of inconsistency and are regarded by many steelmakers as "high-risk" scrap.

In a more recent study[2] on copper content of domestic vehicles, information provided by various investigators showed that copper ranged from about 23 to 53 pounds per vehicle with a breakdown as follows:

Component	Percent of total copper
Radiator	34 to 59
Generator	5 to 10
Battery Cable	3 to 9
Body Wiring	6 to 17
Starter	3 to 17
Starter Solenoid	1 to 3
Heater Core	6 to 13
All Others	5 to 15

In addition, copper is alloyed in the body steel as a residual element at a level of from 0.03 to 0.08 percent. It was also noted that the average total copper content in autos has not changed to any significant extent during the last decade; increase in copper-containing motorized accessories has been offset by improved radiator design and by increased use of substitutes for copper.

Although all the various residual elements have a metallurgical effect on the properties of steel, copper can be particularly troublesome in two ways. In the first case, copper in excess of about 0.20 percent can cause a hot-shortness effect which in turn can cause surface cracking during hot rolling. It is believed that the steel surface is enriched with copper as the iron is oxidized by the associated atmosphere. The copper alloy is molten at the elevated temperature and penetrates the surface intergranularly with consequent cracking under the rolling stresses. The presence of sulfur in the heating atmosphere and excess tin (above about 0.01 percent) in the steel increase the severity of the problem by compound formation of these elements with copper. The maximum copper content to avoid this problem is considered to be about 0.20 percent.

The second effect of copper, as with other residual elements, is to increase the hardness and strength with a consequent decrease in ductility. The presence of copper is therefore severely restricted for those steels to be used in deep-drawing applications. The usual specification limits copper to about 0.05 percent in the steel. Thus the use of automobile scrap for such steels is very restricted due to the relatively high copper content even in the better grades such as shredded material which will normally contain about 0.15 to 0.25 percent copper.

In a recent informative study(3) on the use of No. 2 bundles in the manufacture of drawing-quality steels, it was shown that tin and sulfur have the greatest deleterious influence on mechanical properties. The effect of copper was found to be relatively slight and related to the effect of tin. It was concluded that satisfactory mechanical properties of the steel could be obtained with total residual alloy content (Cu+Ni+Cr+Mo+Sn) up to 0.16, and copper and tin not exceeding 0.09 and 0.01 respectively. It was also noted that the harmful effect of an increase of 0.01 percent in total residuals can be neutralized by a decrease of 0.001 percent sulfur.

Up to the present, no commercial process has been developed for the removal of copper from liquid iron or steel. Recent work(4) with sodium sulfate and mixed sulfates indicated lowering of copper content of molten iron by about 40 percent with 20 percent addition of sulfate. Further study may improve the efficiency of the process, but at present it would appear to be handicapped by economic and operational limitations.

Shredding or fragmentizing hammermill facilities allow for considerable lowering in the copper content by the use of magnetic separation of ferrous and nonferrous materials. In a rather extensive investigation(5) on fragmentized scrap it was determined from the steel industry that lower levels of contamination are required if automobile scrap is to be used in greater amounts. A copper residual of 0.15 percent maximum was cited as the goal for such increased usage. It was found that when a ripper was used on an auto hulk to tear it into eight or ten pieces followed by shredding and magnetic separation, that a melt of 14 tons of scrap gave a copper content of 0.12 percent which was better than any previously known results. A subsequent test with an additional screening and magnetic separation step gave a copper residual of 0.07 percent after melting. It was concluded that the initial ripping operation liberates attached copper more effectively, thereby minimizing entrapment in shredding. Tests were then made on ripping and shredding of cars which had been flattened after stripping; the copper content was again at 0.12 percent and nickel had been reduced five points to 0.12 percent (due to stripping of exterior trim). Tests on magnetic separation rates showed that less copper was removed at high separating speeds. It was concluded that a "ripper-shredder" system with a highly efficient magnetic separator could consistently obtain copper levels of 0.12 percent.

The Bureau of Mines conducted an investigation(6) on the removal of nonferrous metals by heating synthetic automobile scrap in a rotary kiln. It was demonstrated that some of the impurities were removed (including copper), but wetting and sticking of copper on the scrap surface limited the removal. It was further concluded that the process was probably impractical commercially because of high metal losses resulting from severe oxidation of scrap, high fuel costs; and excessive refractory damage because of mechanical abrasion and corrosive action of molten metals and their oxides.

To keep the copper content of scrap to a low level it has been suggested(7) that aluminum be used for electrical conductor wire, and ceramic or ferrite magnets be used for stators in small electric motors. In melting the steel, both the aluminum (which would oxidize) and the ceramics or ferrites (which would enter the slag) would be separated from the metal.

A major part of the Stone(2) investigation covered the redesign of automotive components to eliminate or decrease copper content, while providing for easier maintenance as well as scrap removal. Included in the recommendations of that study are redesign suggestions related to component location and attachment, improved access, substitute materials, voltage boosts, microelectronics, and others. It was also suggested that aluminum or copper-clad aluminum wire be evaluated as a replacement for copper wiring and that the use of printed circuits be considered.

The interest, effort, and accomplishment in scrap quality improvement has been significant over the last several years. However, the ideal status of scrap as a valuable and utilitarian raw material resource will not be attained until all scrap is marketed on the basis of standard size and composition specifications.

Scrap Charges

The types of scrap used in iron and steel melting varies significantly with the type of melting furnace used, operating practice, scrap quality, scrap price, and end product requirements. Optimum scrap usage is often superseded by "past practice" considerations.

TABLE VIII-1. TYPICAL FURNACE CHARGES

I. Steelmaking

Blast Furnace

	Percent	Percent	Percent	Percent
Coke	26	21	23	25
Iron Ore & Agglomerates	64	51	60	64
Scrap (mostly turnings, etc.)	2	10	5	--
Mill Cinder, Scale, Fines	2	7	5	5
Flux Materials	6	11	7	6
End Product	Hot Metal			

Open Hearth

Hot Metal	42	55
Scrap	58	45
#1 Heavy Melting	30	30
#2 Heavy Melting	8	10
#2 Bundles	10	5
Shredded	10	-
End Product	Pipe & Tubing	Typical Mix

Basic Oxygen Furnaces

Hot Metal	69	70	65
Scrap	31	30	35
#1 Heavy Melting	20	10	10
#2 Heavy Melting	5	10	6
#1 Bundles	2	5	10
#2 Bundles	3	5	9
End Product	Flat rolled products		

Electric Furnaces

Hot Metal	45	—						
Scrap	55	100	100	100	100	100	100	100
#1 Heavy Melting	35	20	25	25	37	35	45	40
#2 Heavy Melting	—	50	--	30	--	—	15	20
#1 Bundles	—	--	35	--	40	35	5	5
#2 Bundles	--	25	--	35	3	10	20	25
Shredded	15	—	—	—	--	--	5	10
Turnings	5	5	--	10	—	--	5	—
#1 Bushelings	--	--	40	--	20	20	5	--
End Product	Plates	A-36(.40C) Structural	Special Quality Bar	CQ 1020 Steels	High Quality Steels	Medium Quality	Rebars	

II. Iron and Steel Castings

Cupola

Pig Iron	20	10	--	--	40	20
Scrap	80	90	100	100	60	80
Cupola Cast	20	--	--		25	20
Rail, cut structural and plate	30	60	--	10	--	60
Casting returns	30	30	40	45	35	30
Cut automotive	—	—	30	20	--	--
Shredded	—	—	30	--	--	--
#1 Bundles	--	--	--	20	--	--
Turnings and borings	—	—	--	5	--	--
End Product	Class 30 Gray Iron	Class 40 Castings	Auto-motive	Auto-motive	Valves and Fixtures	High Strength Castings

Open Hearth

Pig Iron	5	25
Scrap	95	75
Rail, cut structural and plate	20	12
Cast steel #1	25	15
Cut automotive	15	8
Alloy scrap, including returns	30	30
Foundry steel, 2 ft. and under	5	10
End Product	Steel Castings	

Electric Furnace

Pig Iron	--	--
Scrap	100	100
Cast Iron	--	30
Low Phosphorus Plate	15	10
Turnings	30	--
Iron Borings	10	20
Returns (gates, risers, etc.)	45	40
End Product	Class 30 Gray Iron Castings	
	Induction Furnace	Arc Furnace

Many variations occur in actual practice, but in general, the higher the end product requirements, the greater the proportion of higher quality scrap used. Scrap size and density are other important factors, e.g., the cupola and blast furnace, due to charge openings, require smaller sized scrap than an open hearth.

Examples of typical furnace charges appear in Table VIII-1 on the following page.

One example of the operating impact of various grades was demonstrated in a series of open hearth test heats conducted at Keystone Steel and Wire Co. The production rates for No. 1 grades were about 17 percent higher than with No. 2 grades. In addition, the ingot yields for No. 1 grades and No. 2 heavy melting ranged from 89.3 percent to 90.7 percent versus 85.3 percent for No. 2 dealer bundle heats. A summary of the operating data from these heats is shown in Table VIII-2 below.

TABLE VIII-2. OPERATING DATA FROM TEST HEATS

Material	Ladle Copper, Pct	Ladle Sulphur, Pct	Burnt Lime, Lb per Ton	Heat Time, Hr:Min	Fuel, Btu per Ton, 10^3
Factory bundles	0.04	0.014	72	10:28	4,540
No. 1 heavy melt	0.11	0.020	79	10:22	4,440
No. 1 dealer bundles	0.09	0.015	96	10:49	4,580
Car-side bundles	0.25	0.024	102		
No. 2 heavy melt	0.39	0.033	97	12:12	5,063
No. 2 dealer bundles	0.45	0.035	137	12:11	5,642

Source: Lindemuth, L. B., Jr. Properties and effects of various commercial scrap grades. Presented at 46th National Open Hearth and Basic Oxygen Steel Conference, American Institute of Mining, Metallurgy, and Petroleum Engineers, 1963.

Iron and Steelmaking Processes

Blast Furnace Practice

In normal blast furnace practice, the primary source of iron units is ore, either in lump or agglomerated form such as sinter or pellets. The amount of scrap used (per ton of pig iron produced) in the blast furnace burden has been relatively constant at an average of about 5.1 percent for the 1967-1969 period as shown in Table VIII-3.

TABLE VIII-3. BLAST FURNACE STATISTICS FOR UNITED STATES, 1965-1969

Year	Blast Furnace Pig Iron Production (thousand net tons)	Consumption of Scrap in Blast Furnaces (thousand net tons)	Scrap Consumed as Percent of Pig Iron Produced
1965	88,185	4,736	5.37
1966	91,500	4,802	5.25
1967	86,984	4,280	4.92
1968	88,780	4,267	4.81
1969	95,017	4,779	5.03

Source: Derived from Annual statistical reports. New York, American Iron and Steel Institute.

Information on scrap usage in blast furnaces is rather limited, apparently as a result of lack of interest or economic incentive to justify investigations on this subject. Rice(8) has reported on blast furnace tests with up to 98 percent scrap as iron source. Results indicated that pig iron production per day could be doubled by going from no scrap to about 100 percent scrap and that with the same limits, the coke rate could be lowered over 40 percent. As he noted, however, for a 98 percent scrap charge, a cupola operation would be much more efficient as a melting unit with a much lower coke rate than the blast furnace. In the tests, a major problem was observed in that after 27 days with virtually a 100 percent scrap burden, production became negligible due to the formation of scaffolding and annular scabbing from partly fused steel turnings. He postulated that totally prereduced ore might bring about similar unhappy results.

In an article(9) on the use of the hot-blast cupola in steelmaking it was noted that large amounts of small, heavy material such as nuts, rivets or punchings should not be charged as they pack too tightly with the risk of hang-ups.

Thus it can be concluded that appropriate size and shape may be important factors in scrap usage in blast furnaces. However, Rice's fears about the use of prereduced ores in blast furnaces is now known to be unwarranted. Several investigations(10-15) have clearly shown that the use of prereduced lump ore, briquettes, or pellets, present no operating problem and appreciably increase productivity and decrease coke consumption. There was no indication of a tendency for slipping, hang-ups, or scab formation in the furnace.(13) In the investigation by Woolf(14) data were presented on the injection of iron powder into the blast furnace through water-cooled lances inserted through the face plates and extending to the nose of the tuyeres. Two levels of iron injection were tested; 20 and 40 percent of the total iron. Operations proceeded smoothly with substantial benefits in coke and productivity, although the advantages were much less at the 40 percent injection rate. These various investigations suggest that from an operational point of view, prereduced burdens up to 100 percent can be successfully used.

However, economic evaluations(16,17) of the use of prereduced burdens indicate that the estimated savings may be negligible or non-existent, depending on the cost for the direct reduction of ore. During recent years it has been indicated that cost estimates for both capital and operations, by promoters of the various direct reduction processes, generally have been optimistic. Thus there would appear to be a possible economic advantage for iron units from scrap versus prereduced ore in blast furnace operations.

There is realistic technical justification for possible increased ferrous scrap recycling to the blast furnace by means of tuyere injection of granules or powder (from scrap) and by the use of scrap of appropriate size and shape as part of the burden. It has been reported in a survey of domestic steel-producing companies(18) that one company specifically stated that more scrap could be used in their blast furnaces if it were available in small sizes at an attractive price. To capitalize on this opportunity for increased recycling, it will not only be necessary that the technology and metallurgical parameters be more completely developed for tuyere injection and additions to the burden in proper size, but the steel industry must make a sincere cooperative effort with scrap processors and brokers to achieve the objective.

Open-Hearth Steelmaking

One of the intrinsic features of the open-hearth, reverberatory-type furnace for steelmaking is raw material versatility which permits scrap usage in amounts from zero to virtually 100 percent. Competition from the BOF process with its higher efficiency and producing rate has caused a decline in open-hearth production during the last several years, and it is anticipated that this trend will continue. It is therefore difficult to envision any technological developments which would bring about increased or new opportunities for scrap recycling in open-hearth furnaces.

Basic Oxygen (BOF) Steelmaking

Although BOF steelmaking has been widely accepted and utilized for the efficient conversion of hot metal to steel, an inherent limitation on operational versatility (as compared to the open hearth) has been the restriction on the amount of scrap that can be used. In normal practice, no external fuels are used in the operation. Heat is obtained by the rapid, exothermic oxidation, by means of gaseous oxygen, of the carbon, silicon, and manganese dissolved in the liquid hot metal supplied by the blast furnace. The excess reaction heat, over that required to bring the steel to the required tapping temperature, is used to melt cold steel scrap in quantity of about 25 to 30 percent of the total metallic charge.

Over the last decade various ideas have been considered that would permit increased scrap utilization in BOF furnaces. One which has been investigated in a number of ways is the preheating of the cold scrap or other cold metallic charge by means of an external or additional heat source.

One report(19) on a commercial scrap-preheating operation describes the use of an oxygen-natural gas burner to heat scrap within the BOF converter. This technique was incorporated in the design of the facility because of limited blast furnace capacity as related to required steel production. The average percent of scrap was increased from 25.7 percent with no preheat to 35 percent with a 17-minute preheat. With the limited amount of hot metal, preheating has allowed the plant to produce from two to four additional 135-ton heats of steel per day.

Reports(20,21) on still another operation which was limited by available hot metal covered the use of oxygen-natural gas preheating, both with and without the use of solid silicon carbide as fuel addition. For this operation it was found to be impractical to preheat more than 20 minutes, and the silicon carbide was utilized if additional heat was required for a 40 percent scrap charge. Under cost and price conditions which prevailed at the time of the study, it was indicated that the use of increasing amounts of scrap decreased the total cost of the metallic charge per se. It was also found that the use of increased scrap above the base of 28 percent increased heat cycle time about 15 minutes.

In an investigation(22) involving over 1,200 commercial heats of 200 tons each, considerable information was obtained on the use of calcium carbide as a solid-fuel BOF addition to permit increased scrap utilization. Most of the tests were made with 40 or 51 percent scrap in the charge. Although successful operations were obtained with the higher scrap and calcium carbide, several problems were noted: (1) almost four times as much fluorspar flux had to be used per ingot ton, (2) oxygen consumption increased by 15 to 25 percent, (3) yield decreased from 87.0 to 85.5 percent, (4) lining life suffered considerably, (5) tap-to-tap time increased from 10 to 15 minutes, (6) cost of materials increased, and (7) use of calcium carbide was found to be limited to the production of low-carbon steels. In a more recent paper(23) concerning the same operations, it was disclosed that the use of a new type of oxygen-fuel oil burner had been successfully developed and used instead of the calcium carbide method. The scrap was preheated within the converter prior to the hot metal addition and scrap charges of up to 50 percent were made. As in other cases, however, the iron oxide formed on the scrap during the preheat cycle was found to cause adverse effects on the refractory bottom of the converter. Despite this difficulty, it would appear that the problems with such a high thermal energy release burner are significantly less than those associated with the use of calcium carbide.

A few investigations have been made on the use of a 100 percent cold charge to the BOF. Rinesch(24) has reported on Austrian developments in which a variety of charges including cold pig iron and scrap, and all scrap plus coke, were converted to liquid steel. This was achieved by the use of a lance with a nozzle design which could be used not only for fuel (oil or gas)-oxygen heating, but could also be used for oxygen refining.

In the United States, the results of an investigation with a pilot scale (30-ton) converter with external scrap preheating facilities for 100 percent utilization have been reported.(25) Preheating was done in refractory-lined charging buckets with air-natural gas burners. After charging the desired amount of coke (as fuel) and calcium carbide, silicon carbide, or ferrosilicon to the converter, the preheated scrap was added, and if required an oxygen-natural gas burner was applied to the scrap. When the appropriate temperature was reached the charge was ignited with oxygen and lancing continued with finishing done in a manner similar to conventional BOF methods.

Only a limited amount of information is available concerning the economics of scrap preheating. A condensation of a comparative cost evaluation which has been reported(26) is presented in Table VIII-4. As can be seen, the cost of the use of in-process fuels will restrict any widespread usage. To date no economic appraisal has been definitive with regard to all pertinent factors including the cost effect of increase or decrease in heat-cycle time.

There are numerous factors which are pertinent to the use of scrap preheating or internal fuels for increased scrap utilization in BOF furnaces. Some of the pros and cons are summarized below:

Advantages

(1) With preheat or internal fuels, more scrap can be used to economic advantage when prices are low.

(2) Total plant productivity can be increased even if hot metal supply is limited.

(3) Steelmaking becomes more flexible, which could permit the shutdown of remaining open-hearth shops in some plants.

(4) If hot metal requirements can be lowered or controlled, high capital costs for new or modernized blast furnaces can be eliminated or delayed.

TABLE VIII-4. COMPARISON OF METHODS OF INTERNAL SCRAP PREHEATING AND IN-PROCESS FUELS IN BOF CONVERTERS

Heat size	200 tons
Normal scrap charge	30 percent
Scrap charge with preheat	40 percent

	Preheating		In-Process Fuels	
	Natural Gas	Fuel Oil	Silicon Carbide	Calcium Carbide
Additional costs per heat:				
Natural gas @ $0.50 per 1000 scf and fuel oil @ $0.075 per gallon	$39.00	$49.00	--	--
Silicon carbide @ $160 per ton and calcium carbide @ $100 per ton	--	--	$400.00	$550.00
Oxygen @ $0.40 per 1000 scf	39.00	64.00	18.00	27.00
Burnt lime @ $15 per ton	(29.00)*	(29.00)	143.00	(41.00)
Fluorspar @ $40 per ton	--	--	(12.00)	28.00
TOTAL	$49.00	$84.00	$549.00	$564.00
Additional costs:**				
Per ton steel	$0.25	$0.42	$ 2.75	$ 2.82
Per ton of increased scrap	2.13	3.65	23.87	24.52

*Parentheses indicates decreases and cost credit.

**No cost allowance has been made for cycle time, lining life, and yield change.

Source: See Reference 26.

(5) If preheat is done externally, the heat-cycle time can be shortened.

(6) Home scrap can be economically converted to steel if production of such scrap is in excess of the amount usable in normal BOF practice.

(7) Provides a technically feasible method for increased ferrous waste recycling and conservation of natural resources.

Disadvantages

(1) If preheat is done internally, the cycle time per heat is increased.

(2) Carbide fuels are expensive and can cause troublesome operating problems.

(3) Control of scrap preheating is difficult by present methods due to variation in size and shape of scrap; large pieces or bundles cannot be heated rapidly, while thin scrap with high surface to weight ratio tends to oxidize easily.

(4) The use of highly oxidized scrap can cause operating problems due to a decrease in the amount of reaction heat released in the furnace.

(5) Lack of control on average temperature and oxidation level of preheated scrap can result in reblows, delayed heats, and a variety of metallurgical problems.

(6) Fuel efficiency in scrap preheating can be rather low depending on the physical conditions for convective heat transfer, final preheat temperature, burner oxygen-fuel ratio, and duration of preheat cycle.

Other Potential Methods for Increased BOF Scrap Utilization. Stone(30) has presented a detailed review and analysis of various techniques and process modifications (other than scrap preheating) which would permit increased scrap usage in basic oxygen steelmaking. Included in the hypothetical process innovations were the following.

(1) Increase in temperature of hot metal. The normal temperature of the hot metal when added to the BOF is about 2400F to 2450F. With a final steel temperature aim of 2900F to 2950F, there would be considerable additional thermal energy available for increased scrap utilization if the hot metal were hotter and more closely approximated the final tap temperature.

(2) Use of silicon as fuel by increase in silicon content of blast furnace hot metal and by the addition of ferrosilicon to the hot metal.

(3) Addition of carbon to the hot metal.

(4) Use of increased manganese and phosphorus as fuel in the hot metal.

(5) Preheating oxygen and/or fluxes.

(6) Recovery of sensible and combustible heat values in effluent gases by utilization for preheating scrap or fluxes or for precalcining of limestone.

(7) Fundamental changes in the BOF process which would convert more CO to CO_2 inside the furnace.

Conclusions. The considerable effort that has been expended in the past on developing methods for increasing scrap usage in BOF steelmaking is indicative of the genuine interest and desirability of achieving such an objective. Further investigations along the following lines would prove valuable:

(1) Carry out an in-depth study of the state of the art to provide definitive information on all aspects of internal and external scrap preheating. This should be broad enough to cover scrap preheating as related to electric-furnace melting. Aside from the technical aspects, a major part of this effort should be a rigorous economic analysis that would include cost effects of increase or decrease of

heat-cycle time and the consequent impact on productivity.

(2) Evaluate all qualitative and quantitative considerations of the potential applicability of preheating of scrap by electrical resistance heating as described in greater detail in the section covering electric-furnace operations. If promising, define and execute an experimental program.

(3) Evaluate all aspects of the potential for the use of large (100- to 150- ton or larger) line-frequency induction furnaces for holding and superheating hot metal. A number of this type of furnace have been built in the indicated size and require the lowest capital investment of all the various types of induction furnaces. If hot metal were superheated 400F (from 2450F to 2850F) and with power efficiency of 70 percent and cost of power at 9 mills, it would take about 52 kwhr per ton and the power cost would be about $0.47 per ton of hot metal. To accomplish such superheat for 150 tons of hot metal in 1 hour would require a power supply of about 75000 kilowatts (which is not very large). The availability of such furnaces would permit the additions of selected fuel elements such as carbon to the hot metal. The surface of the bath could be protected from oxidation of the metalloids by a reducing atmosphere or coke or charcoal cover layer. It would also be possible to carry out desulfurization of hot metal if desired.

Hot-Blast Cupola

The use of the hot-blast cupola as a source of hot metal for steelmaking has been developed and used to a considerable extent in Western Europe. Information is available on this type of cupola operation and its use in conjunction with BOF steelmaking(9,27-29). The metallic charge for the cupola consists entirely of scrap (purchased and revert) and sometimes some pig iron or ferroalloys. Due to the countercurrent nature of heat transfer in shaft furnaces, the cupola is a relatively efficient unit for melting. Hot metal can be produced which is perfectly satisfactory for use in BOF furnaces to produce high-quality steel. The cupola in use by Allegheny Ludlum Steel(29) produces 50 tons per hour which is used in the BOF production of a variety of grades of silicon steels.

Despite the versatility of the hot blast cupola, there is no economic justification for its use as a replacement for the blast furnace. It will find its use in special circumstances where blast-furnace hot metal is not available or where new small steel plants are built which cannot justify or efficiently use a blast-furnace facility.

Electric-Furnace Steelmaking

In electric-furnace steelmaking practice in the United States, the normal metallic charge is essentially all scrap. Most of this scrap is steel, but some may be cast iron such as parts of ingot molds or stools. Thus one could conclude from such prima facie evidence that there are no opportunities in this area for increased scrap utilization. Further thought would show, however, that if new technological innovations could be developed that would significantly lower the costs of electric-furnace steel, the use of the method will grow at the expense of competitive processes with consequent increase in total scrap consumed. There does appear to be certain potential techniques that could provide for lower total cost per ton of steel and that should be systematically investigated and evaluated.

Continuous Charging. In recent years a number of investigations(31-34) have been made on the use of prereduced iron ore (lump, pellet, briquettes, and powder) for the production of steel in electric furnaces. It has generally been found that if such prereduced materials are batch charged to the furnace as in normal practice, operational difficulties are encountered which usually result in longer heat times and higher energy requirements. This problem led to a study of continuously charging of the prereduced material. The following important advantages were noted with continuous charging:

(1) Energy and time requirements are generally lowered by a significant amount.

(2) Furnace operation is dependent upon the degree of metallization; the less oxides and gangue present the greater the efficiency.

(3) Even metallized powder can be added and melted continuously with improvement in energy consumption and heat time.

(4) Electrode and refractory consumption may be significantly lowered when continuous feeding is used instead of conventional batch charging.

In one investigation(33) the tests were made in an experimental combined shaft-electric furnace in which prereduced iron pellets were preheated in the shaft and continuously charged to a rotating-hearth electric furnace shell which was attached to the shaft. A saving in electrical energy of about 27 percent was reported.

As a logical extension of such studies, work(35,36) was also carried out that included tests on the continuous back-charging of scrap. Selected shredded scrap was charged to the furnace by means of a belt feeder and funnel arrangement. The results indicated that heats with 50 and 75 percent of continuously charged shredded scrap showed the lowest energy consumption when compared to the continous charging of prereduced materials such as briquettes, powder, and pellets. It was also shown that the highest energy consumption was required for high-scrap heats made by the normal method of interrupted batch-charging. Thus the data indicate that the continuous charging of scrap after meltdown of the original scrap charge can result in substantial decreases in both kwhr per ton and heat-cycle time.

Preheating of Scrap. Over the years a variety of techniques have been investigated(37-42) for the use of preheated scrap in electric furnaces. Early work on preheating of scrap utilized oxygen-gas burners that were inserted through the furnace door or through special wall ports. Such burners were used to provide supplementary combustion heat during the melting period. Beneficial results included increases in productivity of from 15 to 20 percent and decreased energy consumption with no evidence of any change in refractory or electrode consumption.(38) Other development activities have been directed toward the design and utilization of charging buckets or preheaters in which the scrap is heated by air-gas burners. After reaching the desired temperature, the scrap is charged into the electric furnace. The benefits usually cited are that energy from low cost fuels is partially substituted for more expensive electrical energy and the heat time is reduced.

Some of the problems with external air-fuel burner preheating are as follows:

(1) The scrap can only be heated to a limited temperature (about 1200F to 1400F) so as to avoid excessive oxidation.

(2) Convective heat transfer is dependent on the size and shape of the scrap. Efficiency may also be poor depending upon the depth of the charge and preheat cycle time.

(3) External preheating requires additional manpower and space.

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Indirect advantages of external preheating are reported (private communication to be as follows:

(1) The scrap in the preheater bucket softens and slumps which means the weight of hot scrap per unit volume is greater than for cold scrap. Thus fewer backcharges can be made with an overall decrease in heat time.

(2) Cold scrap contains oil and other combustibles that give a surge of smoke and fume when dropped into the electric furnace. The electric furnace hoods do not function during the backcharge period and thus smoke and fume escapes. Such smoke and fume can be removed from the scrap during preheating by the use of gas collectors over the preheater. Thus the net effect of preheated scrap is less air pollution.

As in the case of BOF steelmaking, one of the major advantages of scrap preheating for electric furnaces that is stressed time and time again is increased productivity. Calculations have been presented in the literature which show the cost savings per ton of steel by the substitution of fuel for electric energy, but there has been little or no effort in the past to quantify the value of increased productivity. Table VIII-5 is a reasonable preliminary appraisal of the potential value of increased steel production per unit of time for a round-the-clock "mini steel plant" facility with normal production of 200,000 tons of liquid steel per year. The costs that are estimated for incremental steel production which may be obtained by scrap preheating are believed to be generally valid up to a production increase of about 25 to 30 percent. An inherent assumption in some of these costs is that such an increase in production can be achieved with little or no increase in manpower, capital investment, or consumption of raw materials. For instance, in many steelplants the ladle crew and furnace crew

TABLE VIII-5. COMPARISON OF ESTIMATED COSTS FOR NORMAL ANNUAL ELECTRIC FURNACE PRODUCTION OF 200,000 NET TONS OF MOLTEN STEEL AND FOR INCREMENTAL TONNAGE WITH INCREASED PRODUCTIVITY

	Normal Amount	Cost per Normal Net Ton, dollars	Cost per Incremental Net Ton, dollars
Metallics			
Scrap Composite	2130 lb	31.10	31.10
Finishing Additions			
FeMn	16 lb	1.44	1.44
FeSi, 50 percent	8 lb	0.64	0.64
Scrap Credit	60 lb	(0.88)	(0.88)
Subtotal		32.30	32.30
Cost Above Metallics			
Electric Furnace Power	520 kwhr	4.68	1.42*
Other Electric Power	20 kwhr	0.18	--
Electrodes	11 lb	3.30	
Burnt Lime	90 lb	0.81	0.81
Fluorspar	12 lb	0.30	0.30
Refractories (Furnace and Ladle)		1.80	0.90
Oxygen	125 cu ft	0.22	0.22
Utilities		0.55	--
Maintenance and Miscellaneous Supplies		1.30	0.65
Operating Cost--Air Cleaning Facility		0.45	0.45
Subtotal		13.59	4.75
Direct Labor	0.78 man-hr	4.21	1.05
Administrative	$200,000/yr	1.00	--
Subtotal		5.21	1.05
Fixed Charges			
Depreciation	$298,000/yr	1.49	--
Insurance and Taxes	$ 89,000/yr	0.45	--
Subtotal		1.94	--
TOTAL PRODUCTION COST		53.04	38.10

* Represents cost of gas above the total normal electric power costs. Assume all of scrap charge preheated to 1200° F, power cost at $0.009/kwhr, gas preheat fuel at $0.60/MM Btu, preheat efficiency at 50 percent, and production per day increased 31 percent (570 NT to 750 NT).

are idle part of the time while a heat is being processed in the electric furnace. If a continuous casting machine is part of the facility, it could be utilized to a much greater extent of its capacity than is presently the normal case.

As can be seen from the tabulated figures, we assume that there will be n no increase in actual electric arc furnace operating time per day and only that preheated raw material input will increase furnace throughput. Thus we conclude that there should be no increase in electrode consumption per day, or putting it another way, there will be notelectrode consumption per incremental ton produced. The general rationale for the other adjustments should be understandable; the cost for direct labor, of $1.05 per ton would be high if no additional manpower was required; operating costs for air cleaning might conceivable be lower for the incremental tonnage, and obviously administrative and fixed charges can be taken as essentially zero for the additional tonnage above normal.

As the results indicate, there would be a net decrease in production cost of $14.94 per net ton of incremental production. From this would have to be deducted the costs assigned to the preheating of scrap other than the fuel gas costs which have been included in the calculations. For the 31 percent production **increase (180 tons per day) used in the calculations,** the savings (unadjusted for **preheating costs other than fuel) per day would be: 180 tons x $14.94/ton = $2,690,** which is certainly a substantial amount and equivalent to about $940,000 per year based on a 350-day year. Even though the figures are preliminary and will probably require some modification, the potential savings and increased profitability which may accrue from such process innovations are of such magnitude that they should warrant a serious definitive evaluation of the economics of preheating or other means of increased productivity. The values in Table VIII-5 should not be considered sacred, but clearly show that there may be several important and large cost factors which have heretofore been neglected.

A recent Japanese development(43-45) describes the custom forming of scrap bales for electric furnaces. The first U.S. installation was at Southwest Rolling Mills in Los Angeles. The press is designed (in this first installation) to produce a 20-ton bale which conforms to the interior configuration of the furnace and provides a complete charge that eliminates backcharging. In addition to increasing production from 20 to 30 percent, the following benefits are also claimed: (1) energy costs are lowered about 10 percent, (2) electrode breakage is eliminated, and (3) refractory wear is lowered by 20 to 50 percent. The production of bales up to 75 tons has been suggested as feasible.

All of the work on preheating of scrap has been oriented toward the use of fossil fuels (mainly gas) with a consequent saving per energy unit as compared to the electrical energy for which it is substituted. However, as was shown previously there are problems with such preheating methods, and as the cost estimates in Table VIII-5 show there may be important savings in increased productivity that are in no way related to this fuel-electricity differential. From this, one can conclude that it would be of value to investigate the general idea of external electrical resistance preheating (disregarding the energy cost comparison) of scrap bales which are preformed to fit inside the electric furnace. A very preliminary schematic illustration of the idea is shown in Figure VIII-1. A simple description of the operation might be as follows. A bale of scrap, preformed to the desired size and shape so that no backcharging is required, is placed on the conductive hearth with (if needed) a thin layer of coke to provide electrical contact and a coke layer placed on top of the bale and the top electrical contact cover lowered to press tightly on the top surface. The shell is made of a refractory which will have high thermal insulating properties and also be electrically nonconductive. Power would be applied so that the scrap bale would be heated throughout by electrical resistance to the current flow. Organic materials in the bale would be volatilized and pass out through the holes in the top cover and could be conveniently collected with a small suction hood. When the proper temperature is reached, the bale is removed from the furnace and charged to the electric melting furnace. Removal from the furnace could be achieved by several possible schemes: a split side shell which could be drawn away from the bale, raise the side shell from around the bale and remove the bale from the bottom, or raise the top ram, swing it aside, and raise the bale up through the furnace shell on the bottom pedestal. It should be emphasized that the idea is but embryonic in development, but it is considered to have several potential advantages:

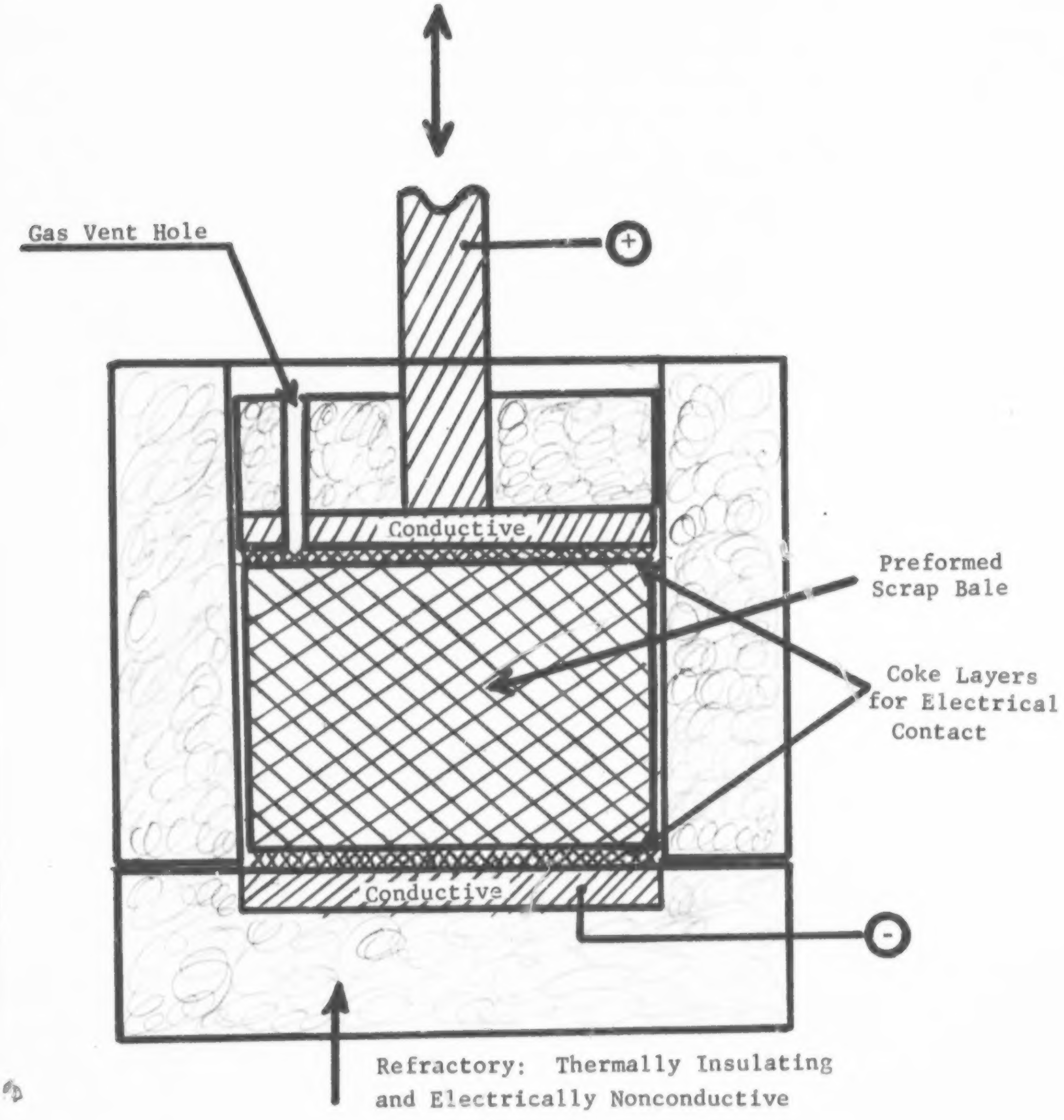
(1) No backcharging would be required.

(2) Negligible generation of waste gases; no products of combustion as with a burner.

(3) High heating efficiency; it is conceivable that with good thermal insulation and consistent preheat cycle that heating efficiency could approach 85 to 90 percent.

(4) A much wider variety of type of scrap such as low-cost crushed machine turnings, chips, etcetera, along with other sizes of scrap can be incorporated in the bale.

FIGURE VIII-1. SCHEMATIC ILLUSTRATION OF ELECTRICAL RESISTANCE FURNACE FOR PREHEATING BALED SCRAP


Gas Vent Hole
+
Conductive
Preformed
Scrap Bale
Coke Layers
for Electrical
Contact
Conductive
-
Refractory: Thermally Insulating
and Electrically Nonconductive

(5) **Carbonaceous materials could be added to the bale if desired.**

(6) Higher preheat temperatures could be obtained as compared to fuel preheating for a given level of oxidation.

(7) There would be no scrap oxidation of any consequence even at high preheat temperature.

(8) **Such a furnace operation should be amenable to good temperature control and scheduling.**

Increased Power to Electric Furnaces. In recent years there has been a significant trend toward the design and utilization of electric arc furnaces with much higher power input capability. Furnaces are presently classified rather arbitrarily in three power categories according to rated kw/ton of capacity as follows:

Category	Kw/Ton of Capacity
Regular power	120-190
High power	200-260
Ultrahigh power	300-450

Information has been published(46-49) concerning the electrical characteristics of high-power furnace operation and the benefits to be derived therefrom. The two primary measures of efficiency most often used are the production of steel per hour as compared to some normal base, and the energy consumption per ton of steel produced. Both of these criteria are quantitative functions of energy input rate and heat cycle time. To a considerable extent, efficiency level is related to thermal losses per unit of time which are functions of furnace size and geometry and are relatively independent of the power level to the furnace. Therefore, an increase in power input (an increase in energy input per unit of time) increases the amount of heat that can be utilized in the melting stage of the heat.

Both theoretical and actual comparisons of the effects of increased power input indicate the following results:

(1) Melting time is decreased as compared with that for conventionally powered furnaces, thus providing increased productivity.

(2) Energy consumption is lowered in terms of kwhr per ton of steel.

(3) Electrode consumption per ton of steel produced is decreased.

(4) Essentially no effect on the time required for the final refining operation.

(5) May cause an increase in the unit cost of electrical energy because of demand charges.

Conclusions. Additional studies and investigations related to economic improvements in electric-furnace steelmaking have the potential of increasing utilization of such furnaces with consequent increased consumption of steel scrap. Promising aspects which should be evaluated and investigated are as follows:

(1) Initiate additional test programs on the continuous charging of scrap (shredded, granules, and powder) and evaluate the effects on operational factors and costs. (In a later section suggestions will be made for research on cryogenic crushing and grinding of scrap to produce granules and powder). In the tests on continuous charging, particular emphasis should include, if possible, tests on agglomerated (pellets or briquettes) forms of scrap granules or powder. Further comparison heats should be made for continuous charging of scrap (in various forms) versus

prereduced ores. The economic appraisal of test results should include all factors on the best quantitative basis that can be utilized.

(2) As indicated earlier in the BOF review, a detailed state-of-the-art study should be made on preheating of scrap along with an appraisal of the economic implications. A more accurate and substantive derivation of total electric furnace costs as a function of increased productivity, similar to those presented in Table VIII-5 should be derived to clarify and quantify cost factors other than the fuel-electricity differential. Total cost comparisons should include the effect of different preheat temperatures.

(3) Examine in detail the possible use of electrical resistance preheating of baled scrap as described and illustrated. This would include not only an evaluation of the type and capital cost for the required electrical equipment, but also an economic analysis of the estimated total production costs at various preheat temperatures and heat cycle times. If such a preliminary appraisal appeared promising, an actual experimental program should be developed and initiated.

(4) Compare the economic implications of higher-powered furnaces and scrap preheating for furnaces with regular power input. Both operating and capital cost effects should be analyzed.

Other Pyrometallurgical Processes

Over the last several years a number of new steelmaking furnace processes that involve various thermal and design innovations have been suggested or actually investigated. Some of these are described briefly in the following paragraphs.

Fuel-Oxygen-Scrap (FOS) Process. The FOS process was developed in England in the early 60's and has been briefly described in the literature.(50,51) The vessel is similar in shape to that of an electric-arc furnace except that it has a somewhat greater height-to-diameter ratio. The furnace can be tilted and has a removable roof for charging. There is a central roof opening for the use of the recently developed toroidal oxy-fuel burner.(52,53) The charge may consist of scrap and pig iron, or scrap plus the desired amount of carburizing material. Refining is carried out with the same burner by varying the oxygen and oil feed rates. It is possible to control the reactions so that the correct tapping temperature and carbon content can be obtained. An economic comparison of the FOS process and electric furnace melting has been made(54) indicating that both operating and capital costs should be substantially lower with the FOS process. However, use of the process has been rather limited, and it would appear from the lack of further information that serious problems exist.

Continuous-Counterflow Steelmaking. Thring(55,56) has proposed processes based on increased thermal efficiency by use of heat in waste gases to preheat the incoming cold charge. A hearth-type furnace based on Thring's ideas was constructed at Paderborn, Germany, and includes four successive ramps with three separate pushers at the feed end of the furnace. Although the thermal efficiency was improved (over 50 percent) there has been little further information concerning any expanded use of the process. He also proposed a three-stage, oxy-fuel, electric-furnace process with increased fuel efficiency, but apparently this scheme has never been evaluated, probably because of its complexity.

Hodge(45,57) has suggested a combined vertical-shaft hearth-type furnace heated by air, oxygen and fuel, for the melting of whole auto bodies. The melting would consist of three steps: (1) scrap or auto bodies would be charged into and incinerated and preheated to about 2000F in the top of the shaft, (2) in the mid-section the scrap would be preheated up to about 2400 F, and (3) at the bottom of the shaft and the hearth the final carburizing and melting would take place. The molten product would contain 2 to 3 percent carbon and could be directly charged into an electric furnace or open hearth. One of the important factors attributed to the economics of the process is that it differs from the ordinary cupola in that it uses little or no expensive foundry coke, but instead low-cost natural fuels. Two problems which may arise in such a process are the practical problem of feeding large auto hulks into and down a shaft without serious refractory damage and the presence of metallic impurities in the melt. Its true practicality will only be determined after actual test work.

Torrax Melting System. The Torrax system has recently been described(58) for the conversion of scrap into a molten, synthetic pig iron, for charging to a BOF or other type of steelmaking furnace. It is difficult to conclude that there is any inherent novelty in the process, and that it is essentially a hot-blast cupola with a cleaning system for the effluent gases which will meet pollution-code requirements.

Conclusions. Although the processes described offer certain features which may permit increased scrap utilization in steelmaking, a substantial amount of development work will be required to make a realistic evaluation of the technology and economics.

Scrap Processing

Cryogenic Scrap Processing

Brief mention has been made in the literature(44,59) of the "International Center for High Quality Scrap" (INCH) nitrogen freezing process which was developed in Liege, Belgium. Baled auto bodies go through a liquid-nitrogen cooling tunnel so that the average temperature of the bale is about minus 160F. The bales then pass through a trapdoor into the usual type of hammermill shredder. A commercial facility is presently being built in Belgium. Test work in North America on scrap freezing is reported to have taken place prior to the INCH development. With cryogenics, power requirements are markedly lowered and output greatly increased. Although normal operating costs are lowered from 40 to 60 percent, other costs for the capital required for a nitrogen-generating plant and for production costs to produce nitrogen bring about a standoff in total cost when compared to regular shredding operations.

At this point it would be of value to clarify somewhat the technical aspects of the liquid-nitrogen cooling of scrap. At ambient or elevated temperatures when ferrous materials are subjected to stress (rolling, forging, impact, etc.), they change shape by plastic deformation. However, there is a particular low temperature known as the "transition temperature" below which the metal cannot be plastically deformed and breaks up under stress by "brittle fracture". By cooling to a sufficiently low temperature, therefore, the metal becomes brittle like glass, and breaks very easily under load or impact. Thus the energy required to break scrap becomes much lower since none is taken up in plastic deformation.

Battelle-Columbus believes that cryogenic cooling of scrap should be considered for the crushing and grinding of scrap to fine sizes such as granules (e.g., 1/4 inch by down) and powder. Some of the potential advantages of such processing may be summarized as follows:

(1) It is believed that a very substantial improvement can be obtained in capability for the removal of metallic and nonmetallic impurities from the powdered scrap by a series of magnetic separation steps. Other separation techniques such as gravity beneficiation might also be useful to produce a high quality product. Such cryogenic grinding should produce equiaxed particles rather than flattened platelets.

(2) Auto scrap and/or other low-cost types of scrap such as borings, turnings, and the clean magnetic fraction of processed city refuse could be used. Turnings could be converted to chips for feed to the cryogenic grinding system by prior processing in equipment such as the Arboga crusher(60).

(3) The cost for energy for pulverizing under these conditions should be very low and productivity very high.

(4) If the cost for the scrap which is utilized is low enough and the final product value is high enough, then the costs for nitrogen and cryogenic processing would not be prohibitive.

(5) The powder or granular product could be pelletized in a disc or drum to obtain a feed for blast furnace burdens or steelmaking furnaces as indicated earlier.

(6) The powdered scrap might be saleable as a low-cost substitute for powdered iron presently used in scarfing and cutting applications and in welding rods. With a high degree of beneficiation it may be a substitute for other applications for powdered iron such as forging preforms et cetera. The present price range for the various grades of powdered iron is from 7.4 cents per pound up to 38 cents per pound for electrolytic iron.

(7) Such granular or powdered scrap may find use in the precipitation of copper by a process which is based on particulate iron(61).

(8) With technical development, it may be possible to convert powdered scrap into sintered billets or blooms that can be hot worked into finished shapes. It may be possible to convert the powdered scrap directly into steel strip or sheet or other form. Work has been reported in this area(62) with hot iron powder from directly reduced, iron ore "superconcentrates". Low-density slab produced by sintering was then rolled into full-density sheet. Sheet produced from reduced synthetic magnetite compared very favorably with standard rimmed steel in mechanical properties. Low-density bars were hot swaged into full-density rod.

(9) It should be practical to blend granular or powdered scrap so that large quantities can be produced with uniform composition.

Conclusions. A study should be made of the state of the art of cryogenic crushing and grinding techniques that would be applicable to scrap processing to produce small granules and/or fine powder. A broad-based economic evaluation should be made of such processing techniques and should include a study of the various possibilities for low-cost nitrogen, such as modification of existing large-volume oxygen plants to produce liquid nitrogen. An extensive investigation should be made of the potential utilization of such materials and the criteria for specific product applications. This recommendation on cryogenic processing should be given serious and extensive consideration.

Other Potential Uses of Scrap

Aside from the primary use of ferrous scrap as a recycle raw material in iron and steel processing, few other uses have been found. The two following schemes should be at least explored to the extent necessary to make some reasonable judgment as to their feasibility.

Reinforcement of Concrete With Scrap

Although some superficial considerations have been given to the idea of scrap reinforcement of concrete in the past, further preliminary exploration is warranted. In particular, it is suggested that tests be made to determine the properties of concrete to which varying percentages of relatively small (say 1 inch maximum dimension) scrap particles have been added. A variety of scrap sources including the clean magnetic fraction from city refuse and other low-cost scrap should be investigated. Reinforcing bar in concrete is used generally to carry any tensile loads if and when cracks develop in the concrete. Uniformly distributed scrap particles may actually serve as a homogeneous strengthener throughout the concrete and prevent the initiation of cracking under loads exceeding the strength of the basic concrete. The effect of size and shape (e.g. length-to-width ratio) of the scrap particles on the strength of the concrete could be evaluated by means of standard tests. The degree of promise for such scrap utilization could be evaluated on a preliminary basis with a relatively modest research program and at nominal expenditure of time and money.

Electrolytic Processing of Scrap

Over the years a considerable amount of work has been carried out on processes for the production of electrolytic iron.(63-69) Electrolytes have included chlorides, sulfates, mixed chlorides-sulfates, and others. Both brittle and ductile deposits have been achieved. High-quality electrolytic powder is presently being produced via a chloride electrolytic process in which the anode is Armco iron (low-impurity) plate. Silman(70) has recently reviewed the possibility for the direct manufacture of ductile electroformed iron sheet.

Although electrolytic processes have certain economic limitations, it would be of value to consider the possibility of using such techniques for the conversion of various forms of ferrous scrap into usable products. This would include such low-cost sources as the magnetic fraction from city refuse. Such a study should evaluate the various technical and economic factors and in particular should determine the potential for the direct electrolytic production of iron shapes (e.g. sheet or strip) which will require a minimum of further processing to finished product. The evaluation should include hypothetical processes for the direct use of scrap as the anode and the use of a purified catholyte produced by the separate chemical dissolution of the scrap followed by removal of impurities (e.g. copper).

Summary of Conclusions and Recommendations

From a technical point of view, there are many opportunities for increased recycling of the various forms of ferrous scrap. However, practically all of these potential opportunities will require detailed economic evaluation to determine the conditions under which they are commercially feasible.

To achieve increased scrap utilization there is a need for centralized evaluation, development, and execution of short-range programs married to well-defined, long-range objectives.

The following are the summary recommendations which Battelle offers for consideration as worthwhile technical and economic investigations:

(1) Investigate the economic and technical aspects of blast furnace tuyere injection of scrap granules or powder and increased use of properly sized scrap as part of the burden.

(2) Study in depth, the economics and technology of internal and external scrap preheating for use in both BOF and electric arc furnaces.

(3) Investigate the potential feasibility for the preheating of scrap by electrical resistance heating. If promising, actual experimental work should be initiated.

(4) Evaluate the potential for the use of large line-frequency induction furnaces for superheating hot metal for BOF steelmaking.

(5) Evaluate the effects of continuous charging of scrap to electric arc furnaces.

(6) Determine the economic implications of the use of higher-powered electric arc furnaces.

(7) Conduct a detailed technical and economic study on the use of cryogenic crushing and grinding for the conversion of ferrous scrap to granules and powder. The investigation should include a broad evaluation of the potential areas of utilization for such forms of scrap and the criteria for specific product applications.

(8) Develop and execute a preliminary experimental program on the use of relatively small scrap particles as reinforcement in concrete.

(9) Evaluate the technical possibilities for the use of electrolytic processes for the conversion of scrap to usable forms.

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CHAPTER IX
OTHER MAJOR AREAS

Natural Resource Conservation

The United States has at present ample reserves of iron ore and coal, the two principal natural raw materials used in iron and steelmaking. But the supply is obviously not limitless. Increasing costs of upgrading low grade domestic ores affects the economic use of these materials and their end products, iron and steel. While we are self-sufficient in coal, over 15 percent of our iron ore supply comes from outside North America and is increasing. In times of international crisis, a severe restriction would be placed on our iron and steel industries due to the potential unavailability of foreign supply; increasing foreign consumption rates and naturalization trends pose additional threats. With regard to coal, it may be a matter beyond that simply of conservation of the resource. In a recent presentation to the American Mining Congress Coal convention, it was stated that the U.S. coal industry will have to strain every bit of its productive capacity to meet world steel industry demand for coking coal through 1980, with an attendant increase in prices.*

Conservation of natural resources is a growing concern to our nation. Scrap has already used natural resources; no further drain is required. By the substitution of scrap for pig iron, natural resources are conserved.

Coal

The iron and steel industries consume about 20 percent of total U.S. coal production, principally in the production of coke. Coke, the residue from the destructive distillation of bituminous coal, is the reducing agent used in the production of pig iron (hot metal) in blast furnaces. Each ton of coke requires slightly less than 1.5 tons of coal; each ton of pig iron requires about 0.6 tons of coke; stated another way, each ton of pig iron requires 0.9 tons of coal (Table IX-1).

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*Metalworking News, "Steel's Demand Will Tax Coal Industry," May 24, 1971, p 2.

TABLE IX-1. COAL CONSUMPTION FOR PIG IRON PRODUCTION
1960 and 1965-1970

	Coal Consumption In Production of Coke (thousand net tons)	Coke Production (thousand net tons)	Coal:Coke	Coke:Pig Iron	Coal:Pig Iron
1960	71,369	50,181	1.42	.749	1.064
1965	83,930	58,618	1.43	.656	.938
1966	85,520	59,649	1.43	.641	.917
1967	82,698	57,465	1.44	.631	.909
1968	81,245	56,990	1.43	.624	.892
1969	84,065	58,205	1.44	.626	.901
1970	87,209	59,777	1.46	.630	.920

Source: Based on data contained in Annual statistical report. New York, American Iron and Steel Institute, 1970. p.62-63. Does not include merchant coke producers; only coke plants associated with iron and steel plants.

The amount of coal required for coke production has been relatively stable, while the coke rate has decreased dramatically, principally through the use of hydrocarbon fuel injection in the blast furnace.

Coal consumption by iron and steel uses and coke statistics are shown in Tables IX-2 and IX-3 on the following page.

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TABLE IX-2. COAL CONSUMPTION BY USES—IRON AND STEEL INDUSTRY
(Net tons)

Years	In Production Of: Coke	In Production Of: Steam *	Other Purposes	Total
1970	87,208,680	4,750,906	318,641	92,278,227
1969	84,064,635	5,362,385	530,853	89,957,873
1968	81,245,441	6,106,052	669,233	88,020,726
1967	82,698,190	6,097,949	780,505	89,576,644
1966	85,519,620	6,631,821	759,857	92,911,298
1965	83,930,052	6,687,868	683,825	91,301,745
1964	78,697,974	6,329,202	715,343	85,742,519
1963	67,928,084	6,184,752	697,234	74,810,070
1962	65,994,292	6,458,004	536,037	72,988,333
1961	65,029,245	6,687,093	548,258	72,264,596

* Includes coal consumed in generating electric power.
Similar data not available prior to 1943.

Source: Annual statistical report. New York, American Iron and Steel Institute, 1970. p.63.

TABLE IX-3. PRODUCTION, RECEIPTS, CONSUMPTION AND SHIPMENTS OF COKE BY THE IRON AND STEEL INDUSTRY

(Byproduct and beehive)
(Net tons)

	1970	1969	1968	1967	1966	1965	1964
Production:							
Metallurgical	59,284,431	57,767,974	56,816,300	57,064,984	59,091,048	58,007,727	54,282,466
Other coke	492,125	436,532	173,618	400,113	558,069	610,221	576,224
Total Production	59,776,556	58,204,506	56,989,918	57,465,097	59,649,117	58,617,948	54,858,690
Receipts from:							
Other steel companies	880,997	714,529	791,758	604,354	410,296	542,202	512,214
Merchant producers	3,404,166	3,559,099	3,149,897	3,376,116	3,836,757	4,200,483	4,109,096
Other plants of parent company	13,294,693	13,074,107	11,744,610	11,238,015	13,531,588	14,205,263	13,129,126
Total Receipts	17,579,856	17,347,735	15,686,265	15,218,485	17,778,641	18,947,948	17,750,436
TOTAL PRODUCTION AND RECEIPTS	77,356,412	75,552,241	72,676,183	72,683,582	77,427,758	77,565,896	72,609,126
Consumption:							
Blast furnaces	58,151,094	60,176,114	56,237,836	56,204,659	59,636,608	59,072,192	57,063,389
Foundries	22,591	13,688	14,893	14,345	20,636	24,647	30,633
Other uses	187,849	234,573	178,608	216,408	268,526	422,083	464,302
Total Consumption	58,361,534	60,424,375	56,431,337	56,435,412	59,925,770	59,518,922	57,558,324
Shipments to other:							
Steel companies	2,487,908	1,439,910	837,367	694,077	689,219	646,515	569,800
Outside companies	1,624,990	1,819,085	1,587,063	1,134,800	1,298,315	1,182,353	1,305,743
Plants of parent company	12,895,281	13,717,349	12,144,181	11,864,037	14,168,280	14,793,313	13,828,769
Total Shipments	17,008,179	16,976,344	14,568,611	13,692,914	16,155,814	16,622,181	15,704,312
TOTAL CONSUMPTION AND SHIPMENTS	75,369,713	77,400,719	70,999,948	70,128,326	76,081,584	76,141,103	73,262,636

Similar data not available prior to 1964.

Source: Annual statistical report, American Iron and Steel Institute, 1970, p.62.

This nation is self-sufficient in coal; in addition, the United States is the world's largest exporter of coal, equal to about 10 percent of total production. Although coal is our largest energy resource, its share of the total energy sources has been declining for several decades, and is expected to continue. However, as evidenced in 1970, there are short term disequilibriums in the supply/demand of coal, leading to price fluctuations. Another coke problem concerns pollution during manufacture, although a new coke pellet manufacturing process, designed to eliminate the gas and dust emissions, shows significant promise.*

Iron Ore

Iron ore and its agglomerated products are the major natural raw materials used in iron and steelmaking. Almost all is used in blast furnace production of iron, although a small amount of sinter, pellets, briquettes, etc., is used in steelmaking furnaces. Blast furnace production of pig iron has averaged 91 million tons annually over the last 6 years, with each ton consuming approximately 1.6 tons of iron ore and agglomerates per ton of iron. Blast furnace production, total materials consumed, agglomerated products statistics, and consumption of materials per ton of pig iron are shown in Tables IX-4, IX-5, IX-6, and IX-7.

TABLE IX-4. CONSUMPTION OF ORE, SCRAP, MILL CINDER, LIMESTONE, AND COKE PER NET TON OF PIG IRON PRODUCED

(Net tons)

Products	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961
Iron ore and agglomerates *	[illegible]	1.567	1.608	1.560	1.536	1.514	1.531	1.530	1.557	1.577
Scrap *	0.036	0.039	0.036	0.039	0.043	0.044	0.043	0.046	0.044	0.043
Mill cinder, scale etc.	0.059	0.059	0.057	0.063	0.062	0.083	0.091	0.091	0.094	0.091
TOTAL	1.668	1.665	1.701	1.662	1.641	1.641	1.665	1.667	1.695	1.711
Limestone and dolomite †	0.246	0.244	0.241	0.257	0.268	0.279	0.274	0.284	0.282	0.301
Coke *	0.630	0.626	0.624	0.631	0.641	0.656	0.655	0.669	0.690	0.708

* Based on total material charged less products recovered.
† Based on total limestone and dolomite charged directly into blast furnaces, plus tonnage consumed in the production of agglomerates. Similar data not available prior to 1910.

Source: Annual statistical report. New York, American Iron and Steel Institute, 1970. p.50.

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*Clean coke pellet process test to cost $20 million. American Metal Market, p.1, June 25, 1971; A cleaner way to make coke. Business Week, p.1, July 31, 1971.

TABLE IX-5. BLAST FURNACE PRODUCTION

(Thousands of net tons)

Year	Number of Blast Furnaces on Jan. 1	Blast Furnace Production		
		Pig Iron †	Ferroalloys	Total
1970	228	91,435	381	91,816
1969	230	95,017	463	95,480
1968	230	88,780	553	87,647
1967	232	86,984	663	92,150
1966	236	91,500	650	88,859
1965	239	88,185	674	86,212
1964	244	85,601	611	72,375
1963	247	71,844	531	66,291
1962	259	65,641	650	65,295
1961	260	64,631	664	67,320
1960	263	66,481	839	60,829
1959	266	60,194	635	57,764
1958	265	57,158	606	79,339
1957	262	78,375	964	75,959
1956	261	75,068	891	77,790
1955	261	76,858	932	58,687
1954	260	57,966	721	75,857
1953	258	74,901	956	62,151
1952	251	61,313	838	71,228
1951	250	70,274	954	65,440
1950	248	64,587	853	54,176
1949	246	53,413	763	61,044
1948	239	60,055	989	59,314
1947	233	58,329	985	45,548
1946	241	44,779	769	

† Includes silvery pig iron after 1963. 1963 and previous years included with ferroalloys.
Similar data not available prior to 1900.

Source: Annual statistical report. New York, American Iron and Steel Institute, 1970. p.45.

TABLE IX-6. AGGLOMERATED PRODUCTS*

(Net tons)

	1970	1969	1968	1967	1966
Materials Used:					
Ore fines and concentrates	92,734,970	94,349,152	92,396,601	88,560,907	89,542,769
Flue dust and sludge	3,228,350	3,452,802	3,455,426	4,131,686	4,661,915
Scale	3,695,427	3,720,456	3,544,342	3,431,559	3,287,503
Coke breeze	2,266,675	2,290,189	2,247,994	2,309,236	2,486,341
Coal	464,359	622,660	747,819	819,052	896,969
Cinder and slag	625,231	768,477	466,682	329,502	332,889
Limestone and dolomite	8,430,260	8,799,262	8,512,911	7,929,735	7,903,032
Other	1,645,015	1,755,295	1,979,162	1,976,898	1,591,862
TOTAL MATERIALS USED	113,090,587	115,758,293	113,350,937	109,488,575	110,703,280
Produced From Above Materials:					
Sinter	45,608,624	49,046,756	48,379,765	51,068,111	54,307,227
Pellets	48,282,920	46,446,708	44,984,905	38,050,646	36,055,999
Briquettes, nodules and other	118,871	154,323	146,016	1,695,004	614,936
TOTAL PRODUCTION	94,010,415	95,647,787	93,510,686	90,813,761	90,978,162
Receipts of Foreign Production:					
Sinter	D	D	D	D	D
Pellets	11,467,603	8,630,417	11,172,945	9,293,103	9,319,136
Briquettes, nodules and other	D	D	D	D	D
TOTAL	11,619,512	8,757,510	11,409,521	9,516,559	9,614,881
Consumed In:					
Blast Furnaces—					
Sinter	45,893,277	49,909,510	49,776,	51,638,941	54,660,669
Pellets	61,544,213	58,460,704	50,737,	43,453,448	41,557,226
Briquettes, nodules and other	1,566,244	1,553,047	1,910,6	1,793,657	945,456
TOTAL	109,003,734	109,923,261	102,424,3	96,886,046	97,163,351
Steelmaking Furnaces—					
Sinter	D	D	D	D	435,283
Pellets	578,159	631,702	678,854	603,974	649,577
Briquettes, nodules and other	D	D	D	D	104,300
TOTAL	916,798	990,951	1,069,904	988,474	1,189,160
TOTAL CONSUMPTION	109,920,532	110,914,212	103,494,302	97,874,520	98,352,511

* Includes ore agglomerates whether produced at consuming plants, at or near the mine site or several non-consuming plants in the United States. The latter two includes plants owned and operated by Bethlehem Steel Corp., Buffalo Sintering Corp., Cleveland-Cliffs Iron Co., Erie Mining Co., Jones & Laughlin Steel Corp., Republic Steel Corp., Reserve Mining Co. and United States Steel Corp.
Similar data not available prior to 1955.

Source: Annual statistical report, American Iron and Steel Institute, 1970, p.57.

TABLE IX-7. MATERIALS USED BY BLAST FURNACES IN MANUFACTURE OF IRON (PIG AND MOLTEN) AND FERROALLOYS IN 1970

Products	Thousands of net tons of Material Used—For		
	Iron (Pig & Molten)	Ferroalloys	Total
Ore:			
Iron ore (incl. manganiferous and block)	38,186	32	38,218
Manganese ore (incl. ferruginous manganese)	103	739	842
Agglomerated products (sinter, pellets, etc.)	109,003	—	109,003 *
Total ores and agglomerated products consumed	147,292	771	148,063
Less flue dust and sludge produced	3,433	37	3,470
Net—Ores & agglomerated products consumed	143,859	734	144,593
Scrap:			
Total scrap consumed	4,120	9	4,129
Less produced at blast furnaces & auxiliary units	886	8	894
Net—Scrap consumed	3,234	1	3,235
Mill cinder, roll scale, etc.	5,425	1	5,426
Limestone, dolomite, other flux materials	14,063	202	14,265
Coke:			
Total coke consumed in blast furnaces	59,149	572	59,721
Less coke breeze (dust) recovered	1,552	18	1,570
Net—Coke consumed	57,597	554	58,151

Similar data not available prior to 1917.
* Includes production at or near mine site and at other locations.

Source: Annual statistical report, American Iron and Steel Institute, 1970, p.51.

While the United States theoretically could be self-sufficient in iron ore, we are becoming increasingly economically dependent on high quality foreign ores. U.S. ores have an Fe content of about 33 percent; the ores of our two primary sources, Canada and Venezuela, have Fe contents of 38 percent and 59 percent respectively. Other foreign sources, mainly Brazil, Chile, Liberia, and Peru, have Fe contents exceeding 50 percent.

In 1960, about 28 percent of our ore supply came from foreign sources, including Canada; this had increased to 34 percent by 1970. U.S. production has trended downward, while imports have been increasing (Figure IX-1).

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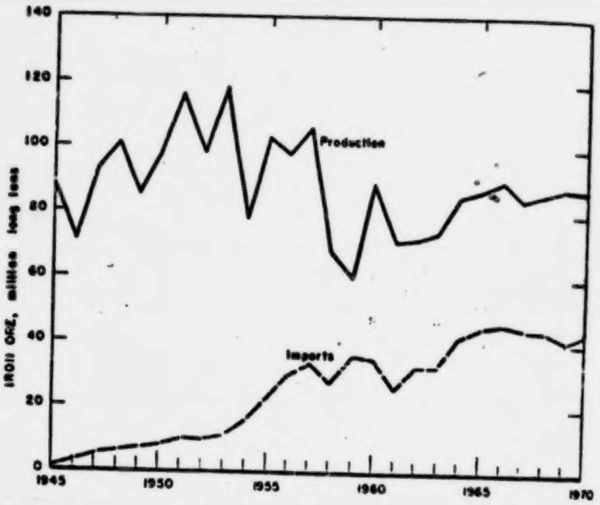
FIGURE IX-1. UNITED STATES IRON ORE PRODUCTION AND IMPORTS FOR CONSUMPTION



Source: Iron ore. In U.S. Bureau of Mines. Minerals yearbook. Washington, U.S. Government Printing Office, 1969. p.560.

Canada and Venezuela, as noted above, are our major suppliers, accounting for 53 percent and 29 percent respectively, of 1970's imports. Imports by country are shown in Table IX-8 below.

TABLE IX-8. IMPORTS OF IRON ORE BY COUNTRIES
(Thousand gross tons)

Country	1970 [r]	1969 [R]	1968	1967	1966	1965	1964	1963	1962	1961
Brazil	1,992	1,233	1,257	1,623	2,723	2,279	1,055	781	1,299	889
Canada	23,919	18,979	26,338	24,214	23,941	23,756	24,854	18,891	16,825	9,683
Chile	1,581	1,783	1,441	1,365	2,268	2,660	2,712	2,679	3,400	2,604
Liberia	1,873	3,144	2,942	3,099	3,390	2,769	2,873	1,310	757	715
Mauritania	71	...	...	24	107	113	133	...		...
Mexico	37	...	...	...	...	10	22	1	145	123
Nigeria	29	...				23	72	...		
Peru	1,329	1,003	925	879	1,043	957	580	290	573	1,209
Sweden	172	155	232	148	82	57	93	37	32	78
Venezuela	13,025	13,751	10,313	12,820	12,592	12,273	9,954	9,231	10,328	10,478
Other	848	685	493	439	113	206	60	43	50	26
Total	44,876	40,733	43,941	44,611	46,259	45,103	42,408	33,263	[a] 33,409	25,805

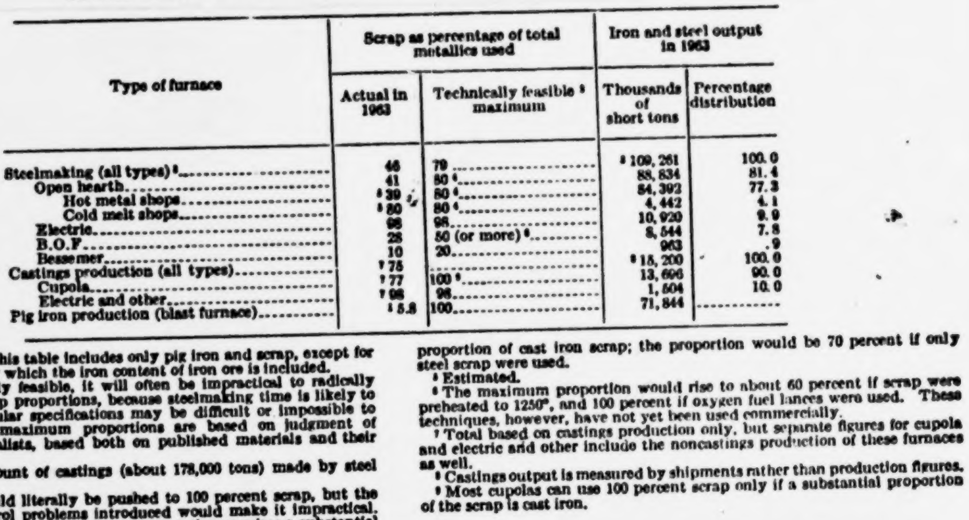
Similar data not available prior to 1901.

Source: Annual statistical report, American Iron and steel Institute, 1970, p.59.

Substitution of Scrap for Pig Iron

The two sources of iron for iron and steelmaking are iron ore and scrap. Typically, the Fe content of beneficiated ore is 60 percent, whereas scrap is 90 percent. To a great extent, the two are technically interchangeable. Recognizing that it may be impractical to radically change scrap proportions because of increased steelmaking time and/or costs or problems involving final product specifications, a 1966 study estimated the technically feasible maximum scrap proportion of ferrous metallics that could be used in the making of iron and steel (Table IX-9).

TABLE IX-9. TECHNICALLY FEASIBLE MAXIMUMS IN THE SCRAP PROPORTION OF TOTAL METALLICS[1] USED IN THE MAKING OF IRON AND STEEL



Type of furnace	Scrap as percentage of total metallics used		Iron and steel output in 1963	
	Actual in 1963	Technically feasible[2] maximum	Thousands of short tons	Percentage distribution
Steelmaking (all types)[3]	46	79	[3] 109,261	100.0
Open hearth	41	80[4]	88,834	81.4
Hot metal shops	[5] 39	80[4]	84,392	77.3
Cold melt shops	[5] 80	80[4]	4,442	4.1
Electric	98	98	10,920	9.9
B.O.F	28	50 (or more)[6]	8,544	7.8
Bessemer	10	20	963	.9
Castings production (all types)	[7] 75		[8] 15,200	100.0
Cupola	[7] 77	100[9]	13,696	90.0
Electric and other	[7] 98	98	1,504	10.0
Pig iron production (blast furnace)	[5] 5.8	100	71,844	

[1] Total metallics in this table includes only pig iron and scrap, except for pig iron production, for which the iron content of iron ore is included.

[2] Although technically feasible, it will often be impractical to radically change customary scrap proportions, because steelmaking time is likely to be increased or particular specifications may be difficult or impossible to meet. Estimates of maximum proportions are based on judgment of BDSA industry specialists, based both on published materials and their own experience.

[3] Includes small amount of castings (about 178,000 tons) made by steel ingot producers.

[4] The maximum could literally be pushed to 100 percent scrap, but the cost and quality control problems introduced would make it impractical. For cold melt shops, the 80 percent scrap proportion requires a substantial proportion of cast iron scrap; the proportion would be 70 percent if only steel scrap were used.

[5] Estimated.

[6] The maximum proportion would rise to about 60 percent if scrap were preheated to 1250°, and 100 percent if oxygen fuel lances were used. These techniques, however, have not yet been used commercially.

[7] Total based on castings production only, but separate figures for cupola and electric and other include the noncastings production of these furnaces as well.

[8] Castings output is measured by shipments rather than production figures.

[9] Most cupolas can use 100 percent scrap only if a substantial proportion of the scrap is cast iron.

Source: U.S. Department of Commerce, Business and Defense Services Administration, Iron and Steel Scrap Consumption Problems, 1966, p 14.

While achievement of these technical maximums in practice is not economically feasible, there is little doubt that an increased proportion over today's practices could be used, without significant increase in operating costs or quality deterioration, assuming proper scrap preparation and prices.* Therefore, the increased use of ferrous scrap in iron and steelmaking is technically possible and environmentally desirable.

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*Some upward movement from the 1963's actuals has already occurred.

Transportation of Ferrous Scrap

The ferrous scrap industry is faced with the need to transport material in two basic phases of its operation. These are the movement of unprepared scrap from the source to the scrap processor, and the movement of prepared scrap from the processor to the consumer.

Scrap Movement

Unprepared ferrous scrap is normally transported via private carrier and usually by truck unless large quantities are involved, such as that sold on a bid basis from large auto body plants or some unprepared scrap that must be moved a great distance. There is some movement of unprepared scrap by common carrier, either rail or truck, but the overall percentage of total movement by common carrier is small and limited to high value scrap. Prepared scrap, on the other hand, is usually shipped via common carrier and normally by rail.

The Extensive Survey provided the information in Table IX-10 on the following page regarding the mode of transportation used for raw material delivery and processed scrap shipments. 80.2 percent of the companies interviewed have more than 75 percent of their raw material delivered by truck while only 29.6 percent of the companies ship more than 75 percent of their scrap via truck. The preference for truck delivery is due to two things: one, unprepared scrap is usually not available in sufficient quantity at a single location to utilize rail transportation, and two, many firms have their own trucks and do much of their own collecting and delivery.

The preference for rail shipment (over 45 percent of the firms ship more than 75 percent of their scrap via rail) is due in large part to the fact that most steel mills require rail shipments only. This is a generally valid requirement due to mill layout and it would probably be more costly from a handling standpoint to accept scrap shipments via more than one mode. However, more and more mills are accepting scrap in truck shipments, especially the shorter haul shipments of up to 150 to 200 miles. For example, much more truck movement of scrap from processor to user has been noted in the large Chicago consuming area primarily due to the unavailability of cars and generally poor railroad service in the area.

Table IX-10 also compares transportation modes used five years ago with those used today. As can be seen, the usage of truck shipments both inbound and outbound has increased slightly while the usage of rail transportation has decreased slightly.

TABLE IX-10. ESTABLISHMENTS USING TRANSPORTATION MODE - TODAY AND 5 YEARS AGO (Percent)*

Raw Material Delivered	Percent of Companies Using Mode		Processed Scrap Shipped	Percent of Companies Using Mode	
	Today	5 Years Ago		Today	5 Years Ago
By Truck	96.4	91.9	By Truck	80.2	74.1
Less than 26 percent	5.3	4.0	Less than 26 percent	34.8	36.4
26- 50 percent	4.5	6.9	26- 50 percent	9.7	10.5
51- 75 percent	6.5	7.7	51- 75 percent	6.1	5.7
76-100 percent	80.2	73.3	76-100 percent	29.6	21.5
By Rail	52.6	53.0	By Rail	78.1	76.9
Less than 26 percent	39.3	38.5	Less than 26 percent	17.0	9.7
26- 50 percent	6.5	7.7	26- 50 percent	7.7	10.1
51- 75 percent	2.0	3.2	51- 75 percent	8.1	10.1
76-100 percent	4.9	3.6	76-100 percent	45.3	47.0
By Barge	1.2	1.2	By Barge	2.8	2.0
Less than 26 percent	1.2	1.2	Less than 26 percent	2.0	0.8
26- 50 percent	0.0	0.0	26- 50 percent	0.4	0.4
51- 75 percent	0.0	0.0	51- 75 percent	0.0	0.8
76-100 percent	0.0	0.0	76-100 percent	0.4	0.0

* Percentages are not weighted for volume shipped.

Source: Extensive Survey

Tables IX-11 and IX-12 compare the economic raw material supply radius and scrap shipping radius of five years ago with that of today. Both tables indicate that in general, the radius of operation (both raw material and processed scrap) is decreasing. For example, if the radius had remained the same the diagonal entries in the table would read 100 percent. If the radius had increased, the entries to the right of the diagonal (larger current distance) would so indicate. Thus, entries to the left of the diagonal indicate a decrease in the economic radius of operation.

TABLE IX-11. COMPARISON OF ECONOMIC RAW MATERIAL SUPPLY RADIUS 5 YEARS AGO WITH TODAY (Table entry is percentage of establishments having a supply radius as indicated 5 years ago that have the supply radius indicated today.)

Radius Material Supply 5 Years Ago	Total	Radius of Miles Material Supply Today 0 To 50	51 To 100	101 To 200	201 To 300	301 To 400	401 To 500	501 To 750	Over 750
0 To 50 Miles	100.0	92.2	6.7	1.1	0.0	0.0	0.0	0.0	0.0
51 To 100 Miles	100.0	25.9	72.2	1.9	0.0	0.0	0.0	0.0	0.0
101 To 200 Miles	100.0	4.2	16.7	79.2	0.0	0.0	0.0	0.0	0.0
201 To 300 Miles	100.0	0.0	8.3	8.3	75.0	0.0	0.0	0.0	8.3
301 To 400 Miles*	100.0	0.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0
401 to 500 Miles*	100.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	25.0
501 To 750 Miles*	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
More Than 750 Miles	100.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0

* Sample size less than 10.

Source: Extensive Survey.

TABLE IX-12. COMPARISON OF ECONOMIC PROCESSED SCRAP SHIPPING RADIUS 5 YEARS AGO WITH TODAY (Table entry is percentage of establishments having a shipping radius as indicated 5 years ago that have the shipping radius indicated today.)

Radius Scrap Shipped 5 Years Ago	Total Total	Radius of Miles Scrap Shipped Today 0 To 50	51 To 100	101 To 200	201 To 300	301 To 400	401 To 500	501 To 750	Over 750
0 To 50 Miles	100.0	90.0	6.7	0.0	3.3	0.0	0.0	0.0	0.0
51 To 100 Miles	100.0	6.9	86.2	3.4	3.4	0.0	0.0	0.0	0.0
101 To 200 Miles	100.0	2.4	16.7	78.6	0.0	0.0	2.4	0.0	0.0
201 To 300 Miles	100.0	5.6	5.6	11.1	72.2	0.0	5.6	0.0	0.0
301 To 400 Miles	100.0	9.1	0.0	9.1	9.1	72.7	0.0	0.0	0.0
401 To 500 Miles	100.0	0.0	7.1	0.0	21.4	7.1	50.0	0.0	14.3
501 To 750 Miles	100.0	9.1	0.0	0.0	0.0	0.0	18.2	72.7	0.0
More than 750 Miles	100.0	0.0	3.4	0.0	3.4	3.4	17.2	3.4	69.0

Source: Ibid.

Economics of Scrap Transportation

The cost to transport a ton of ferrous scrap from processor to consumer represents a significant percentage of the total delivered price of the scrap. For example, at a price of $36 a ton for No. 1 heavy melting steel scrap delivered from Boston to Pittsburgh, the transportation charge of almost $14 a ton represents about 40 percent of the total price. For No. 2 bundles at $25 a ton, the percentage would be 56 percent of the total selling price.

Since all scrap, regardless of value, moves at the same freight rate, some forms of scrap cannot be economically shipped to and from certain points or over long distances. For example, the movement of machine shop turnings from Boston to Pittsburgh would be uneconomical since the freight rate would equal normal purchase price. In this way, many localities relatively far removed from consuming markets cannot economically recycle certain forms of scrap without a subsidy of some sort such as a fee for removing the material from the generator's plant, or an environmental subsidy to collect and dispose of auto hulks or other solid wastes, or export markets which can absorb the transportation costs.

Thus, the cost of transporting scrap to market has a significant effect on the recycling of ferrous solid waste. The magnitude of the problem is increased when the transportation of unprepared scrap is also considered. For example, if the price of scrap fob mill is $30 per ton, shipping charges are $10 per ton, processing costs are $10 per ton, and other costs total $2 per ton, that leaves $8 per ton to cover the collection and transportation of the unprepared scrap, and profit. At $8 per ton, some unprepared scrap will find its way to the processor while other scrap either because of distance or difficulty in collection will not. This type of analysis is particularly meaningful for the shredder operator who is constantly faced with the problem of maintaining a raw material inventory (auto hulks) that in many cases is difficult to collect and transport and for which he cannot afford to pay more than a certain amount.

In other words, transportation of both unprepared and prepared scrap reinforces the economic prejudices against the recycling of low value and/or remotely located solid waste.

Discriminatory Freight Rates

As a raw material in iron and steelmaking, the producer is buying the element iron (Fe). Steel typically contains 98 percent Fe; iron and steel castings have Fe contents ranging upwards from 92 percent. He has two sources of iron: iron ore, a natural resource, and ferrous scrap, a resource already having used the natural resource, ore. Natural ores are defined as those with up to 73 percent Fe; many ores, however, are far lower in Fe content so that complex beneficiating processes are introduced to improve their value. For example, a low grade 55 percent Fe ore or an upgraded pellet of 65 percent Fe both compete metallurgically with ferrous scrap which nominally contains 95 percent Fe. Due to the differences in Fe content, they do not compete on a ton to ton basis, but compete on their relative Fe basis, i.e., the relative iron content when reduced to forms suitable for iron and steelmaking.

It is a generally accepted concept of equity that transportation rates should not alter the competitive standing of the alternative inputs to any manufacturing process. Transportation rates should not disturb these relationships so long as the rates exceed the carrier's cost of providing such service. Equitable rates reflect the basic commodity's value. Present rail rates seemingly create a bias in favor of iron ore over ferrous scrap.

A recent study indicated that the present inequity amounted to approximately $1.50 per gross ton of scrap. The analysis considered 2,000 pounds of scrap at 95 percent Fe as equivalent to 3,167 pounds of iron ore at 60 percent Fe plus 602 pounds coal equivalent energy for reduction of oxide in the ore to metallic form. These equivalents were then modified by the relative role of rail transportation in their movement, and rebased to one gross ton of rail-shipped scrap equivalent (1966 rail share of total movement - 74 percent for scrap, 58 percent for ore, and 65 percent for metallurgical coal). It was therefore determined that 2,240 pounds of rail-shipped scrap competes with 2,780 pounds of rail shipped ore and 391 pounds of rail-shipped coal. The net effect indicated the $1.50 freight inequity.

A further review was made of the economic sensitivity of steelmaking cost to scrap cost. It appeared that the consumption of steel scrap in integrated steelworks and in electric furnaces is held back by existing freight rate discrimination. In the short run, the removal of the present rate discrimination by lowering scrap freight rates would enable steelmakers to experience a significant reduction in the finished cost of steel ingots. In the long run, investment in scrap-based steelmaking would enjoy an improved expected return on that investment.

The consequences, therefore, of the apparent discriminatory rate structure are:

(1) Present scrap markets are impeded in preference to the rate-favored usage of iron ore

(2) Future markets for scrap are being curtailed because new investment that could logically be directed to scrap-intensive steelmaking is diverted artificially to ore-intensive steelmaking

(3) Irreplaceable natural iron ores are exploited when they could be conserved

(4) Iron and steel scrap that could be recycled is unable to move

(5) The environment is despoiled by accumulation of waste.

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Problems Related to Transportation and Potential Solutions

In addition to the problems of discriminatory freight rates and the high costs of shipping scrap to markets discussed above, there are two other major transportation related problems faced by the ferrous scrap industry that directly or indirectly affect the recycling of ferrous solid waste. These are the limited availability of railroad freight cars and a general lack of understanding of transportation and the importance of transportation by many individual members of the industry. All four problems are analyzed in Table IX-13 while possible solutions are discussed in Table IX-14.

Battelle-Columbus feels that the entire transportation issue needs to be examined within the context of recycling to determine:

(1) What is the real magnitude of transportation problems? Only a very small percent of the establishments responding to the Extensive Survey indicated that it was a problem but this may simply indicate a lack of understanding of the real problem.

(2) What is the effect of current transportation policies and practices on recycling and the recycling industry?

(3) What can realistically be done to coordinate the actions of the scrap, steel, and railroad industries relative to the transportation of scrap?

(4) What is the proper role for the Federal Government to take in this area?

Many of these problems are the result of far deeper problems that plague the railroad industry as a whole. It is doubtful that satisfactory solutions can be found for the above problems before the underlying problems of the railroad industry can be solved.

TABLE IX-13. IDENTIFICATION AND ANALYSIS OF PROBLEMS RELATED TO TRANSPORTATION

Problem	Availability of Railroad Freight Cars	Discriminatory Freight Rates	High Cost to Ship Scrap to Market	General Lack of Understanding
PROBLEM DEFINITION	1. There is a shortage of general purpose gondola cars of the type used in shipping scrap.	1. It is argued that, on the average, iron and steel scrap is charged $1.50 more per ton than should be charged if the competitive relationship between scrap and iron ore is to be maintained.	1. Shipping charges represent a significant and often large percentage of the final selling price of a ton of processed scrap.	1. Many firms do not fully understand the importance of transportation to their overall success.
EFFECT	1. Movement of scrap is often delayed pending receipt of cars. 2. Unavailability of cars may result in economic penalties to shippers. 3. Generally poor service may retard recycling effort by encouraging use of substitute materials.	1. Encourages the use of iron ore over scrap on an iron unit basis. 2. May influence long term decisions regarding raw material usage (scrap or ore).	1. Uneconomical to process and ship some lower value scrap. 2. May effect long term decisions on scrap usage by steel mills.	1. Firms may suffer financial loss because optimum transportation methods are not used. 2. High cost and discriminatory rate problems are multiplied by less than optimum performance.
ANALYSIS	1. More general purpose gondola cars are being retired than are being replaced. 2. Since 1954, there has been a 35 percent reduction in the number of gondola cars, and a corresponding 24 percent decrease in tonnage carrying capacity 3. Railroads do not have the capital to invest in new cars.	1. See the analysis of apparent discrimination freight rates appearing previously in this section.	1. Because scrap selling price (fob mill) and processing cost are both fixed--high transportation cost is directly felt in the price that is paid or available to be paid to collect and deliver unprepared scrap to the processor. This directly effects the recycling effort.	1. Firms usually do not allocate much effort toward improving their transportation performance. 2. Freight rate structures and operation are very difficult to understand and effectively use. 3. Railroads are not willing and-or able to give adequate help to individual firms.

TABLE IX-14. SOLUTIONS TO PROBLEMS RELATED TO TRANSPORTATION

Problem	Availability of Railroad Freight Cars	Discriminatory Freight Rates	High Cost to Ship Scrap to Market	General Lack of Understanding
RECOMMENDED ACTION	1. Investigate ways to increase the availability of cars or in some other way improve the service.	1. Determine in greater detail the overall effect of freight rate structure on the movement and usage of scrap	1. Reduce the cost burden of transportation. 2. Determine the need for a subsidy program to encourage recycling	1. Increase the understanding of transportation needs by individual firms in the industry.
BY WHOM	ISIS	ISIS-EPA	ISIS-EPA	ISIS-SCRAP PROCESSORS-RAILROADS-CUSTOMERS
SPECIFIC STEPS	1. Scrap industry ownership of gondola cars or perhaps development of special scrap handling cars. 2. Increase the national car pool of general purpose gondola cars--guaranteed loans to railroads to purchase those cars. 3. Investigate increased use of truck shipments.	1. Increased in-depth analysis should be made to determine the magnitude and actual effect of current rate structures on scrap movement and recycling. 2. Secure corrective action where needed.	1. **Investigate use of mini-train, unit train shipments, or other common pool concepts from central locations to mills.** 2. Institute a study to determine the effects of a subsidy program, including preferential rates for "problem" scrap. 3. Study the feasibility of centralized collection points.	1. ISIS sponsored seminars and short courses to train member firms in areas of transportation. 2. The recently ISIS implemented rate auditing service should be expanded along with similar services in other areas. 3. Attempt to get more co-operation between scrap industry, railroads, and steel industry in area of transportation of scrap.

Governmental Influence on Solid Waste Utilization and Recycling

Governmental influence on solid waste utilization and recycling is felt in at least three different ways. These are the effects on the allocation of resources, effects on the operation of the secondary materials industries, and effects on the consumption of recycled materials. Influences may be manifest in more than one way or area. For example, export regulations affect both the allocation of resources and the operation of the secondary industry by regulating the movement of scrap on an international basis.

Federal

Governmental influence at the Federal level on solid waste utilization and recycling on the whole is moving from a slightly negative stance to being slightly positive or supportive of the recycling concept and the recycling industry. The Resource Recovery Act of 1970 and its predecessor The Solid Wasts Disposal Act in 1965, were significant steps forward in the promotion of the recycling concept.

Title II of the Resource Recovery Act of 1970 is of particular interest because it creates a National Commission on Materials Policy which is charged with--"developing a national materials policy which shall include, without being limited to:

(1) National and international materials requirements, priorities, and objectives, both current and future, including economic projections;

(2) The relationship of materials policy to (a) national and international population size and (b) the enhancement of environmental quality;

(3) Recommended means for the extraction, development, and use of materials which are susceptible to recycling, reuse, or self-destruction, in order to enhance environmental quality and conserve materials;

(4) Means of exploiting existing scientific knowledge in the supply, use, recovery, and disposal of materials and encouraging further research and education in this field;

(5) Means to enhance coordination and cooperation among Federal departments and agencies in materials usage so that such usage might best serve the national materials policy;

(6) The feasibility and desirability of establishing computer inventories of national and international materials requirements, supplies, and alternatives; and

(7) Which Federal agency or agencies shall be assigned continuing responsibility for the implementation of the national materials policy."*

The above excerpt indicates the potential far reaching coordinated effort that could be forthcoming under proper guidance and coordination. For example, one could envision a coordinated national materials policy taking into consideration depletion allowances, stockpile policies, transportation policies, export and import policies, policies affecting the competitiveness of American Industry in world trade, and other factors all of which could form the basis for proper allocation of resources and recycling rather than disposal of solid wastes.

State and Local

State and local influence appears to be directed more at the local scrap processor or dealer than at recycling or the recycling industry as a whole. These influences are usually restrictive in nature and in some cases discriminatory and/or arbitrary in focus. It is often the smaller processor, dealer, or collector who is hurt the most (since he can ill afford to move, fence, or change methods of operation) by these restrictions. For example, urban renewal or highway construction might make it necessary to dislocate a scrap processor and/or collector who was servicing that immediate area of the city. Zoning laws probably make it necessary for the firm to relocate outside of the city and thus may make collection of obsolete scrap from the affected area of the city more difficult if not completely uneconomical. Small operations often leave the industry and go out of business when faced with the problem of moving to a new location. These small operations serve a very valuable function by collecting and perhaps processing lower grades of obsolete scrap. It is this least economical and perhaps ecologically most important area of obsolete scrap recycling that may be hurt most by these types of dislocations essentially caused by progress.

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*Resource Recovery Act of 1970. 91st Cong., House Report 11833, Public Law 91-512, Oct. 26, 1970.

It is important for all levels of government to consider the complete recycling network when proposing or amending legislation or policy affecting or designed to affect the network. Thus, for example, while ecologists lobby for government agency usage of recycled paper, consideration should be given to the effect government influence has on the recycling industry--the collectors, dealers, processors, and brokers of waste paper--and also on the allocation of resources relative to depletion allowances and the use of government owned timber land by the paper industry.

It is hoped that the National Commission on Materials Policy will be another step in the direction of a coordinated effort to increase the utilization of solid waste. The ferrous scrap industry should actively support the efforts of the Commission.

Areas of Influence Affecting Solid Waste Utilization

An analysis of various areas of governmental influence or legislation effecting solid waste utilization and recycling is presented in Table IX-15. The areas identified are: pollution codes; export restrictions; depletion allowances; transportation rates and policies; discriminatory classifications, licensing and restrictions on scrap processors; auto titling laws; and zoning laws. The information contained in this table is general and indeed may be more or less important or applicable in certain regions, industries, or commodities than in others. A more specific treatment of this subject is considered outside the scope of this study.

TABLE IX-15. GOVERNMENTAL AND LEGISLATIVE INFLUENCES ON RECYCLING AND THE RECYCLING INDUSTRY

Influence	Level of Government			Effects			Analysis
	Federal	State	Local	National Allocations or Conservation of Resources	Operation or Efficiency of the Recycling Industry	Market for Recycled or Secondary Materials	
Pollution Codes	X	X	X		X		1) Three levels of legislation cause conflicts and uncertainties with regard to pollution control equipment and continued operation. 2) Different codes in different localities cause industry dislocations. 3) Added financial burden may force some marginal firms out of business.
Export Restrictions	X			X	X	X	1) Export restrictions favored by consuming (smelter) segment of secondary materials industry and opposed by processor/dealer segment of the industry. 2) Degree of restriction effects production levels in primary and secondary sector.
Depletion Allowances	X			X		X	1) Depletion allowances offer advantage to primary producers over secondary producers. 2) Depletion allowances may work against recycling and encourage depletion of natural resources.
Stockpile Policy	X			X	X	X	1) Stockpile policies sometimes reinforce cyclical swings in supply-demand situation thus increasing problems.
Transportation Rates and Policy	X				X	X	1) Transportation (specifically rate structures) policy appears to favor primary material over scrap or secondary material. 2) High costs of transportation often prevent some types of obsolete scrap from being recycled; specifically low-price or high-volume scrap such as steel cans and auto hulks. 3) See Transportation section of Chapter IX.

TABLE IX-15 (cont'd). GOVERNMENTAL AND LEGISLATIVE INFLUENCES ON RECYCLING AND THE RECYCLING INDUSTRY

Influence	Level of Government			Effects			Analysis
	Federal	State	Local	National Allocations or Conservation of Resources	Operation or Efficiency of the Recycling Industry	Market for Recycled or Secondary Materials	
Discriminatory Classification, Licensing and Restriction of Scrap Processors		X	X		X		1) In many cases classifications and licenses do not reflect the secondary materials industry in the proper context; i.e., a manufacturing industry and not a resale or wholesale industry. 2) Scrap processing industry is often legislated against (license requirements, restrictive zoning, fencing) on basis of industry name and not on individual merit or guilt.
Auto Titling Laws		X		X			1) Extremely difficult in some localities to legally collect and dispose (deliver to a auto wrecker or scrap processor) of abandoned automobiles. 2) Modification of many of these laws needed to aid scrap industry in collecting and recycling abandoned autos.
Zoning Laws			X		X		1) Zoning laws in many cases arbitrarily administered and applied to firms based only on company name or function and not on an individual basis. 2) Urban renewal and expressway construction often forces scrap processor or collector out of business permanently since may be difficult to find new area properly zoned or suitable as a base of operations.

Major Problems and Recommendations

Three major legislative problems and recommendations--depletion allowances, pollution codes, and discriminatory classification, licensing, and restriction on scrap processors--and recommendations for solutions are shown in Table IX-16.

As an example of the complexity of alternatives facing state and local governments in policy making, the alternatives for just one ferrous solid waste problem area, the abandoned motor vehicle, is shown in Table IX-17.

TABLE IX-16. IDENTIFICATION AND ANALYSIS AND RECOMMENDED SOLUTIONS TO GENERAL LEGISLATIVE PROBLEMS

	Depletion Allowances	Pollution Codes	Discriminatory Classification, Licensing, and Restriction of Scrap Processors
Problem Definition	1) Primary material industries receive an allowable deduction (15 percent of sales revenue in case of metals) from taxable income.	1) Pollution codes are often changed every few years. 2) Codes are different in various parts of the country. 3) Codes are set up by three levels of government causing confusion. 4) Federal codes encourage states to enact stricter codes.	1) Scrap industry classified as a nonmanufacturing industry. 2) Scrap industry is licensed and restricted based on the name of the industry and not on merit.
Effects of the Problem	1) Creates an unfair advantage in favor of primary materials. 2) Encourages mining companies to sell increased volume of primary metal. 3) Results in misallocation of resources.	1) Creates an unfair burden on some segments of industry while other segments are not affected. 2) Creates unfair advantage to firms in certain geographic areas or states.	1) Industry does not get many of the operating tax breaks (sales tax exemption) accorded to most manufactering industries. 2) Industry (by name--not function) is zoned out of areas zoned for manufacturers in some localities.
Problem Analysis	1) Depletion allowance was originally adopted to encourage exploration and development of natural resources. 2) Currently viewed by many as simply a discriminatory tax break for the natural resource industries. 3) Those companies producing both primary and secondary materials are encouraged to produce and sell primary to obtain depletion allowance. 4) Real effect on recycling is not known.	1) Companies are sometimes faced with having to replace pollution control equipment before old equipment is fully depreciated. New 60-month depreciation rule should help here. 2) It is advantageous to be located in an area with less strict pollution codes.	1) Scrap processor, in many cases, classified on the basis of a historical image of the scrap industry; i.e., the junk collector image. 2) Scrap processing industry classed as retail or wholesale business rather than a manufacturing business.
Recommended Action	1) The effect of depletion allowances on recycling and the recycling industry should be determined. 2) Action should be taken based on the results of a comprehensive study.	1) Coordinate pollution codes at the three levels of government. 2) Investigate ways to reduce the financial burden (to smaller firms) of controlling pollution.	1) Promote the industry and its function as a manufacturer to both the general public, government officials, and the industry itself. 2) Encourage enforcement of legislation on a fair basis--not across the board based on industry image.
By Whom	ISIS-EPA	ISIS-EPA	ISIS and Individual ISIS Firms
Specific Steps	1) Commission a study to examine the effect of depletion allowances on recycling.	1) Lobby for accelerated depreciation rules to be applied in cases where new equipment is required before old equipment is fully depreciated. 2) Investigate "service policy concept" for pollution control equipment and operation.	1) Encourage firms to not use words like "junk" in their names, listings in yellow pages, etc. 2) Encourage more community participation by scrap processing firms on an official basis. 3) Lobby for effective and fair legislation and enforcement.

TABLE IX-17. POLICY ALTERNATIVES FOR STATE AND LOCAL GOVERNMENTS ON ABANDONED AUTO PROBLEM

Economics of Last Owner

Disposal Deposit

Advantages
1. Applicable to a continuing program to prevent abandoned auto problem.
2. Set so that last owner has incentive to claim the deposit.
3. Provides a "bounty system toward recycling.
4. Would utilize present collection and processing industry.

Disadvantages
1. Has not been tried.
2. Creates problems in initiating program.
3. Doesn't take care of backlog.
4. Don't know costs of administration.

Prohibit Storage of Auto Without Registration

Advantages
1. Reduces backlog of junked cars.
2. Frees land for a possible more profitable venture.
3. Reduces health hazard as well as aids beautification programs.
4. May inhibit rebuilding of backlog.

Disadvantages
1. May deny "legitimate" reasons for storage.

Prohibit Abandoning Autos on Public Thorofares

Advantages
1. Involves public attention.
2. Removes or prevents health and safety hazards.

Disadvantages
1. Fine would hit those who can't afford to transport.
2. Costly for city to police and remove.
3. Difficult to locate perpetrator.
4. Doesn't attack basic problem.

Title Clearance

Change Registration Laws

Advantages
1. Reduces double handling.
2. Reduces delays.
3. Reduces administrative procedures and costs for processor.
4. Encourages reduction of backlog and recurrence.

TABLE IX-17 (Cont'd). POLICY ALTERNATIVES FOR STATE AND LOCAL GOVERNMENTS ON ABANDONED AUTO PROBLEM

Disadvantages

1. Cost to administer.
2. Perhaps only a marginal contribution to the solution of the problem.

Autowrecking and Scrap Processing

Bounty

Advantages

1. Encourages reduction of backlog and recurrence.
2. Involves modest administrative costs.

Disadvantages

1. Applies to all vehicles--not just those outside or potentially outside the scrap cycle (the problem autos).
2. Only indirectly subsidizes transportation to processing.
3. Costs of bounty may be unnecessary when scrap price is high.

Tax on Hulks in Autowrecking Yards

Advantages

1. Increases continuity of flow.
2. Reduces volume in yards.
3. Reduces backlog and prevents recurrence.

Disadvantages

1. Costs of administration and policing.
2. Could increase costs of second-hand parts.

Screening at Yards

Advantages

1. If by living screen--a reasonable reduction in esthetic "insult."

Disadvantages

1. Initial costs.
2. Maintenance costs.

Limit Open Burning

Advantages

1. Reduces air pollution.

Disadvantages

1. Increases costs of preparation.
2. Increases volume of material for disposal.
3. May inhibit recycling.

TABLE IX-17 (Cont'd). POLICY ALTERNATIVES FOR STATE AND LOCAL GOVERNMENTS ON ABANDONED AUTO PROBLEM

Collection and Transportation

Bounty to Processor (or Autowrecker)

See above

State Payment to Local Government for Autos Collected

Advantages
1. Applies only to the "problem" autos.
2. Flexible--applicable under any market conditions.
3. Modest administrative costs.
4. Administratively easy to start or end program.

Disadvantages
1. Applies primarily to the backlog problem.
2. Direct costs to state.
3. The only experience with it depends on volunteer help locally.

Contract Crushing and Hauling by State

Advantages
1. Only a portion of transport costs paid, depending on scrap price.
2. Consistent with commercial operations of scrap processors.

Disadvantages
1. Direct costs to state.

Research and Development

For some time, it has been recognized by the iron and steel industry, the scrap industry, and government that ferrous solid waste is a valuable raw material resource when processed into iron and steel scrap, but also a problem when left to accumulate as solid waste. Considerable R&D has therefore been conducted, both economic and technical, aimed at analyzing the industry, its problems, and ways to increase the use of iron and steel scrap.

This work falls into five basic categories:

(1) Increasing the proportion and/or improved operating techniques for increased ferrous scrap use in iron and steelmaking furnaces. Examples include: scrap preheating; solid fuel additions; oxygen-fuel burners; continuous scrap charging; and improved scrap handling equipment. The "Technology" section of this report details much of this effort.

(2) Evaluations directed at use of low-quality scrap in melting furnaces and its effect on finished steel products. Recent examples include the evaluation of the effect of No. 2 bundles on sheet steel quality,(2) and the use of steel cans as a furnace charge.(3)

(3) Use of scrap for noniron or steelmaking applications. Examples include: upgrading of low iron content iron ores by roasting with scrap;(4) use of shredded automotive scrap for copper precipitation;(5) and use of compressed light-gauge auto body scrap as a reinforcing core in concrete building blocks.(6)

(4) Improvement of scrap quality and/or economics through improved scrap processing equipment and operations. Examples include: shredding systems; ripper-shredder combination;(7) development of low-cost junk auto incinerators;(8) improved auto dismantling practices;(9) removal

of undesirable elements from low-quality scrap by thermal or chemical treatment;(10) cryogenic scrap processing;(11) equipment and yard layout studies; (12) and measurement and improvement of scrap quality studies. (13)

(5) General scrap qualitative and quantitative studies. Examples include: specific studies on automobile disposal; (14) scrap consumption problems;(15) regional scrap analyses; (16) supply and availability of obsolete and prompt industrial scrap studies; (17) vehicular component redesign to permit improved processing; (18) numerous composition studies of scrap quality; and other surveys.(19)

In addition, significant work has been conducted recently on both the technical and economic recovery of metals from municipal solid waste.(20)

Significant contributions have been made by many sources, both private and public, toward increased use of ferrous solid waste and a better understanding of the problems and opportunities involved. Solutions to the problems are not simple, and joint efforts are required if success is to be achieved.

The Bureau of Mines of the U.S. Department of Interior in particular has made continuous efforts and contributions toward solutions of these problems. With the passage of the Solid Waste Disposal Act of 1965, the Bureau was able to greatly expand its research on solid waste problems. Working primarily through regional metallurgy research centers and in cooperation with private industry, the Bureau has made many commendable contributions.(21)

Other Government agencies, such as the U.S. Department of Commerce's Business and Defense Services Administration, now absorbed and reorganized into the Bureau of Domestic Commerce, and the Office of Solid Waste Management Programs of the Environmental Protection Agency, have also made significant contributions.(22)

The scrap processing industry and its equipment suppliers have constantly worked on improving the quality and economics of its products. As in most other industries, most of the work done by individual scrap firms has been achieved by only the largest firms, with the capital and technical resources necessary. In order to help all firms, in addition to increasing the emphasis on R&D in the scrap industry, the Institute of Scrap Iron and Steel, in 1967, formed the Scrap Metal Research and Education Foundation. The foundation has funded numerous studies aimed at improving the understanding, economics, and quality of scrap for the benefit of the total industry.

The iron and steel industries have also been active in R&D on ferrous scrap in recent years. Ferrous scrap is the second most important raw material used by these industries, but for a number of years, little effort was expended on its improved utilization. As recent as 1966, a survey of steel companies indicated little or no R&D work aimed at increasing scrap usage, and that little interest existed in involvement with ferrous solid waste problems, such as the junked auto.(23) However, with the advent of the BOF process and its increasing demands for hot metal, research on increased scrap use during times of short availability of hot metal and/or favorable scrap economics relative to hot metal or pig iron was and is being conducted. In addition, the industry has come to recognize certain environmental problems caused by its products, such as the steel can, and research into its use as a furnace charge material and establishment of can collection centers has taken place.(24)

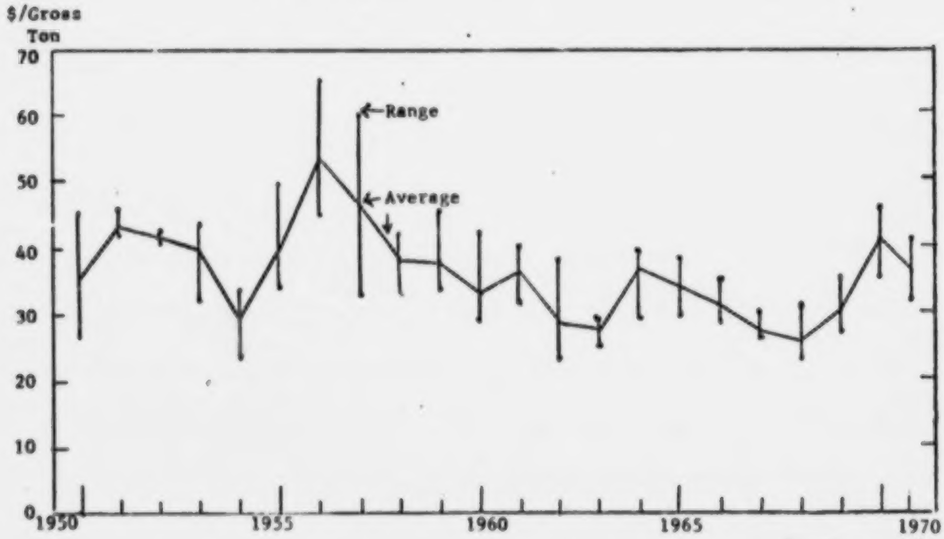
There is, however, little question that greatly increased R&D effort and results are required, by all parties concerned, if increased utilization of ferrous solid waste is to become a reality. Specific recommendations are included throughout this report.

Price Volatility

Scrap is the only major input to iron and steelmaking that exhibits significant price volatility. Costs of other materials, such as coal, iron ore, and limestone, due to ownership interests and long-term purchase contracts, as well as labor and utilities, are substantially known on an annual basis. This allows for financial planning and operating cost efficiencies. The price of scrap however, an important cost consideration for all mills, but in particular to electric furnace operations, has varied significantly in recent years.

During the early and mid-1950's, the price of No. 1 Heavy Melting Steel Scrap, often used as a barometer of scrap prices, ranged from a low of under $27 per gross ton to a high of $65 per gross ton. Variances approaching $20 per ton during a year were not unusual, as can be seen from Figure IX-2 and Table IX-18.

FIGURE IX-2. PRICES, NO. 1 HEAVY MELTING STEEL SCRAP, ANNUAL AVERAGES AND RANGE 1950-1971



Source: Three-city composite. American Metal Market.

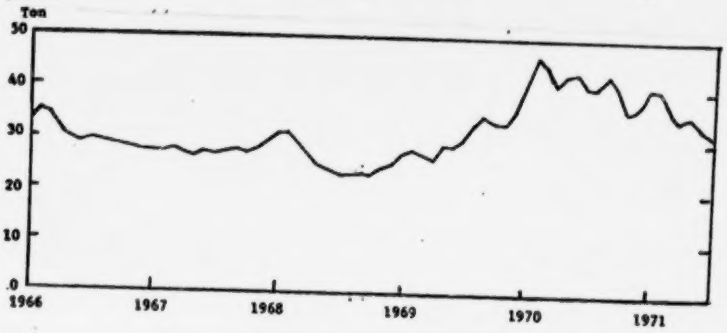
TABLE IX-18. PRICES - NO. 1 HEAVY MELTING STEEL SCRAP ANNUAL AVERAGES AND RANGE, 1950-1971 (dollars)

Year	Average	High	Low	Difference
1950	35.34	44.77	26.64	18.13
1951	43.14	45.97	42.00	3.97
1952	41.89	42.00	40.74	1.26
1953	39.90	43.65	32.17	11.48
1954	28.74	33.38	23.76	9.62
1955	39.75	49.26	33.67	15.59
1956	53.45	64.97	45.28	19.69
1957	47.10	59.74	33.06	26.68
1958	37.81	42.41	33.01	9.40
1959	37.69	44.70	33.70	11.00
1960	33.20	42.07	28.71	13.36
1961	36.37	39.85	31.76	8.09
1962	28.34	37.82	23.66	14.16
1963	26.89	28.71	25.29	3.42
1964	36.50	38.53	28.64	9.89
1965	34.27	37.86	29.54	8.32
1966	30.66	35.03	27.85	7.18
1967	27.63	29.80	26.67	3.13
1968	25.94	31.54	23.11	8.43
1969	30.55	35.56	26.33	9.23
1970	41.25	46.03	35.95	10.08
1971	34.46	40.81	30.81	10.00

Source: Three-city composite. American Metal Market.

However, during the period of 1958 through mid-1969, a degree of price stability was achieved. Unfortunately, beginning in mid-1969, scrap prices increased significantly, suggesting that price stability in scrap, desirable to both processors and users, was a goal yet to be achieved. No. 1 began in 1969 at under $27 per gross ton and steadily climbed to $35 by year end. In 1970, it ranged from a high of $46 to its low around $36. The $10 spread occurred again in 1971. This volatility is shown in Figure IX-3.

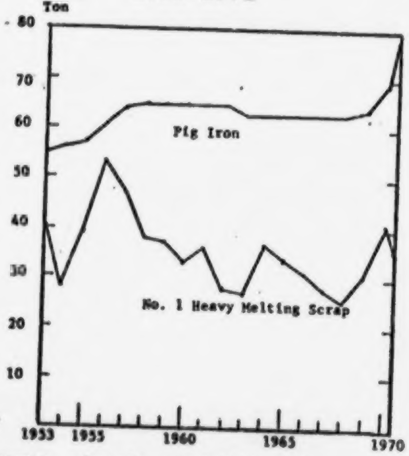
FIGURE IX-3. PRICES, NO. 1 HEAVY MELTING STEEL
1966 - 1971 (monthly)



Source: Three-city composite. American Metal Market.

By contrast, the price of pig iron, scrap's chief competitor for foundry operations, has shown a fairly stable structure, rising a total of $15 per gross ton over the period 1953 through 1970, and without the monthly volatility exhibited by scrap, although significant price increases have occured in 1971. Costs of hot metal, scrap's competitor in integrated steel operations, are not publicly known as it is generally produced by the integrated mills for internal comsumption only, but stable yet increasing costs can be assumed. Typical current costs of hot metal are estimated in the $40-50 per ton range. The price comparison is shown in Figure IX-4.

FIGURE IX-4. PRICE COMPARISON, PIG IRON VS. SCRAP
1953-1971



Source: American Metal Market.

Scrap prices are determined in a relatively free competitive market. Typically, scrap is purchased on 30 to 60 day contracts by the mills from brokers or processors, although some trend toward longer term purchase agreements is taking place as required by increased capital investment for scrap processing equipment. Prices change daily, if not hourly in some cases. The market is extremely responsive to demand, with numerous buyers and sellers. There is some regional domination of major sources of supply to processors, such as automotive industrial accounts, or a major consumer, but in general, the prices are established in a typical free market situation.

Obvious differences of opinion take place as to who actually establishes the price - the scrap dealer/broker or the consumer. The scrap industry feels that scrap is bought, not sold; i.e., demand cannot be created, and scrap is sold only as consumer needs dictate, and at the consumer's price. On the other hand, consumers make the claim that during high demand periods scrap is plentiful only at certain price levels.

However, scrap demand is influenced by its price and quality. The surge in electric furnace steelmaking was partially enhanced by lower scrap price trends and its availability. The increase in BOF steelmaking and attendant dramatic increases in blast furnace hot metal output were influenced by a desire on the part of consumers for lower reliance on scrap, as is the interest in direct-reduced ores as a scrap substitute.

In general, scrap prices have tended to follow classical supply/demand patterns tied to iron and steel production levels. However, with the increased generation of home scrap and lower reliance on total scrap by the integrated BOF producers, a general depression on scrap prices occurred from the mid-fifties until late 1969, when high export demand and prices drove up the domestic scrap prices to the highest levels seen since 1957. While scrap prices have receded from those levels, there is little doubt that scrap prices of the future will exceed those enjoyed by consumers during the mid to late 1960's, as transportation, labor, and processing costs continue to increase for the scrap industry. And those prices will tend to be determined by its value in its marginal uses, where its economics favor use over hot metal or other scrap substitutes, such as direct-reduced ores, or the unavilability of hot metal.

Scrap price volatility normally is caused by short-term disequilibriums in the scrap supply and demand situation. In times of high iron and steel production, the incremental additions for production are not totally available through additional hot metal supply. Therefore, many steel producers who are normally relatively low users of purchased scrap come into the market due to inadequate hot metal. Conversely, when steel demand falls, the demand for scrap also falls as the producers iron inputs can be satisfied from their own hot metal. Thus, in the cyclical markets for iron and steel scrap, demand is highly variable, and scrap prices as a result are volatile, determined as they are in a competitive market.

Obsolescent scrap, the product of ferrous solid waste, is most directly affected by these gyrations in scrap prices and demand. Prompt industrial, because of its relatively high quality and need for constant move into the recycling process from industrial accounts, generally flows well, regardless of price. Loss of industrial accounts for the scrap processor would occur if otherwise. This normally does not offer any significant problem for the processor, as the amount of home and industrial scrap generated follows closely trends of iron and steel production, and therefore demands for purchased scrap. On the other hand, ferrous solid waste is continuously generated. Its movement into the scrap cycle takes place only when it will bring a profit to the scrap processor, covering his purchase, processing and transportation costs, and brokerage fees. Thus, unless the price paid by the iron and steel industry provides coverage of these costs, ferrous solid waste simply accumulates.

Therefore, scrap price and demand volatility, caused by normal free market cyclical conditions, is inevitable. Its major effect is to accelerate the flow of obsolete scrap during periods of high demand and price, and conversely to act as a constraint on movement during low demand and price periods.

Long-term purchase contracts have often been promoted as the answer to the problem of price volatility. Reaction to this proposal is mixed, in both the scrap industry and the steel industry. As long as it is not an industry-wide practice, the risk factor on both sides would be great, and would have a minor effect on the underlying and changing supply and demand relationship which cause price changes. And while desirable from many standpoints, such as stable pricing and more processing continuity, establishment of the right price to allow economic operations for both processor and consumer presents a major obstacle. While perhaps theoretically desirable, the economics and psychology of the marketplace deter such wide-spread adoption of long-term purchase contracts in the near future.

Another suggestion is vertical integration between processors and their markets. Some evidence of this already exists, both in fact and in practice. Certain mini mills started as scrap processors; some scrap processors are located adjacent to consuming mills. Ownership interests in other raw materials is common in the steel industry; scrap may be next. But while this might exercise some control over supply and pricing, it is doubtful that a strong trend in this direction will occur in the near term.

It therefore appears that without major changes in current market conditions and attitudes within the two industries, price volatility will remain although within a narrower range than encountered in 1969-70, but at a higher level than in the 1966-68 period. It also may be seen as a desirable feature. The BDSA report on iron and steel scrap consumption problems stated:

> "Variable prices are the prod that makes scrap flow to areas in which it is most needed; that, to a limited extent, varies the total scrap supply in the direction of changing demand; and that clears the market of the amount supplied. Scrap prices must be highly variable at times if the competitive market is to perform its important service of allocating scrap where it is needed most."(15)

Further economic analysis of scrap prices, supply, and demand appears in the Bureau of Mines study on automobile disposal,(14)

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CHAPTER X

APPENDIX A

EXTENSIVE SURVEY OF THE FERROUS SCRAP INDUSTRY

As a major part of the overall study an extensive survey of the ferrous scrap industry was performed to identify the industry, its capabilities, and its problems. The survey involved the following steps:

(1) Sample selection

(2) Questionnaire preparation

(3) Conduct of interviews

(4) Tabulation of responses

(5) Analysis of results.

Sample Selection

The Institute of Scrap Iron and Steel (ISIS) through its membership of roughly 1,300 establishments (1,100 firms) accounts for the processing of 90 percent of the ferrous scrap in the United States. Based on this fact, the survey sample of 250 was selected to conform to 90 percent ISIS members and 10 percent nonmembers, and represents an estimated 15.4 percent sample of the ferrous scrap industry. The sample and sample alternates were selected, at random, from the ISIS membership directory (listed geographically) and a trade magazine listing of scrap iron and metal dealers.

A total of 322 establishments were selected as shown below:

	Sample	Percent	Interviewed	Percent
ISIS members	266	83	216	87
Nonmembers	56	17	33	13
	322	100	249	100

The variance from the 90-10 breakdown occurred because of incompleted interviews, refusals, and other problems experienced during interviewing.

Figure A-1 indicates the geographic distribution of the sample by state. The distribution of the sample by region and the distribution of completed interviews by region is given in Table A-1. The distribution by city appears on page A-4.

FIGURE A-1. GEOGRAPHIC DISTRIBUTION OF COMPLETED EXTENSIVE SURVEY INTERVIEWS

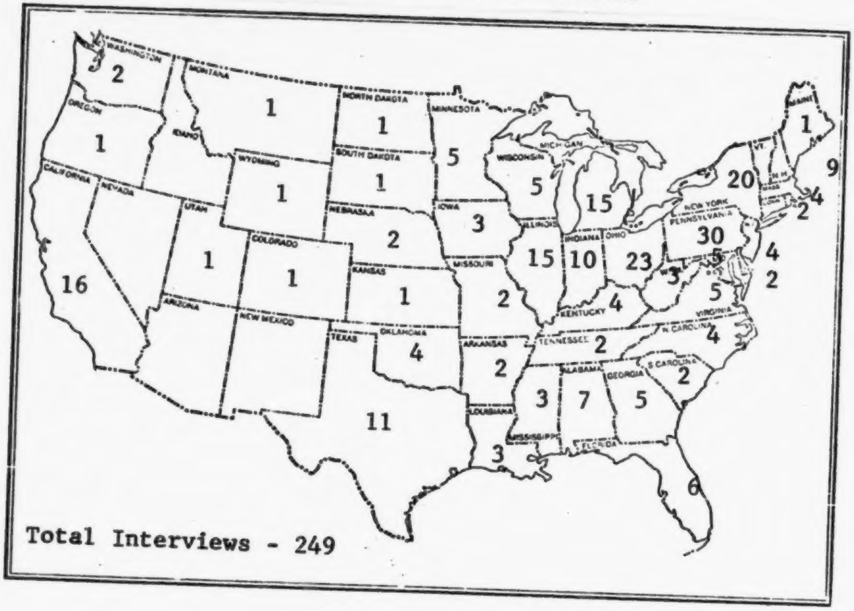
Washington 2
Oregon 1
California 16
Nevada
Idaho
Montana 1
Wyoming 1
Utah 1
Colorado 1
Arizona
New Mexico
North Dakota 1
South Dakota 1
Nebraska 2
Kansas 1
Oklahoma 4
Texas 11
Minnesota 5
Iowa 3
Missouri 2
Arkansas 2
Louisiana 3
Wisconsin 5
Michigan 15
Illinois 15
Indiana 10
Ohio 23
Kentucky 4
Tennessee 2
Mississippi 3
Alabama 7
Georgia 5
Florida 6
S Carolina 2
N Carolina 4
Virginia 5
3
New York 20
Pennsylvania 30
5
4
2
Maine 1
9
4
2
Total Interviews - 249

TABLE A-1. GEOGRAPHIC DISTRIBUTION OF EXTENSIVE SURVEY SAMPLE COMPARED TO VARIOUS MEASURES OF INDUSTRY LOCATION

Region	Percent in Sample	Percent in Completed Survey	Percent of Establishments*
New England	6.4	7.3	6.0
Middle Atlantic	23.7	23.1	21.4
South Atlantic	11.7	12.6	8.8
East North Central	27.3	25.9	28.2
East South Central	6.4	7.3	5.3
West North Central	6.0	6.5	9.2
West South Central	8.0	7.7	8.2
Mountain	1.6	0.8	3.0
Pacific	7.6	8.5	9.9

Source: U.S. Bureau of the Census. 1967 Census of business. Wholesale trade statistics. Washington, U.S. Government Printing Office.

Questionnaire

The questionnaire used in the extensive survey was designed by Battelle. During the design stage the questionnaire was field tested during personal interviews with three scrap processing firms in Columbus, Ohio. The revised questionnaire was subsequently pre-tested under actual telephone interview conditions and again revised. The final questionnaire is presented starting on page A-5.

Interviews

Chilton Research Services, Philadelphia, Pennsylvania, conducted the actual survey interviews. The total number of completed interviews was 249 divided roughly half via personal interview and half via long distance telephone.

Tabulation of Responses and Analysis of Results

The gross tabulation and the regional breakdown of the responses is presented starting on page A-15. Additional information extracted from the survey appears in various sections throughout the report.

GEOGRAPHIC DISTRIBUTION OF EXTENSIVE SURVEY SAMPLE (By state and city)

- (7) ALABAMA
  - Andalusia
  - Birmingham (2)
  - Dothan
  - Mobil
  - Demopolis
  - Tuscaloosa
- (2) ARKANSAS
  - Jonesboro
  - Texarkana
- (16) CALIFORNIA
  - Compton
  - Emeryville
  - Fresno
  - Long Beach
  - Los Angeles (4)
  - Oakland (2)
  - Elmonte
  - San Bernardino
  - San Jose
  - Sante Fe Springs
  - Sun Valley
  - Wilmington
- (1) COLORADO
  - Denver
- (4) CONNECTICUT
  - Bridgeport
  - New Haven (2)
  - Waterbury
- (2) DELAWARE
  - Wilmington (2)
- (6) FLORIDA
  - Jacksonville
  - Lakeland
  - Orlando
  - St. Petersburg
  - Tampa (2)
- (5) GEORGIA
  - Atlanta (2)
  - Augusta
  - Gainesville
  - Savannah
- (15) ILLINOIS
  - Aurora
  - Chicago (6)
  - Decatur
  - East St. Louis (2)
  - Lemont
  - Mattoon
  - Quincy
  - Springfield
  - West Chicago
- (10) INDIANA
  - Connersville
  - Crawfordsville
  - Fort Wayne
  - Hammond
  - Indianapolis (3)
  - Kokomo
  - Rockport
  - Vincennes
- (3) IOWA
  - Council Bluff
  - Des Moines
  - Waterloo
- (1) KANSAS
  - Kansas City
- (4) KENTUCKY
  - Ashland
  - Louisville (2)
  - Newport
- (3) LOUISIANA
  - Crowley
  - Monroe
  - Shreveport
- (5) MARYLAND
  - Baltimore (3)
  - Cumberland
  - Owings Mills
- (9) MASSACHUSETTS
  - Boston
  - Chelsea
  - Leominister
  - New Bedford
  - Pittsfield
  - South Attleboro
  - North Attleboro
  - Tewksbury
  - Worcester
- (1) MAINE
  - Presque Isle
- (15) MICHIGAN
  - Coldwater
  - Detroit (7)
  - Flint
  - Grand Rapids
  - Ithaca
  - Lansing
  - Pontiac
  - Saginaw
  - Three Rivers
- (5) MINNESOTA
  - Anoka
  - Duluth
  - Minneapolis
  - St. Paul
  - Winona
- (3) MISSISSIPPI
  - Greenville
  - Meridian
  - Indianola
- (2) MISSOURI
  - Kirksville
  - St. Louis
- (1) MONTANA
  - Bozeman
- (2) NEBRASKA
  - Lincoln
  - Broken Bow
- (9) NEW JERSEY
  - Bayonne
  - Clifton
  - Jersey City
  - Kearny
  - Newark
  - North Bergen
  - Perth Amboy
  - Port Newark
  - Trenton
- (20) NEW YORK
  - Albany
  - Bronx
  - Brooklyn (2)
  - Buffalo (3)
  - Canandaigua
  - Farmingdale
  - Fulton
  - Jamaica
  - Lockport
  - Newburgh
  - New York (2)
  - Olean
  - Rochester
  - Schenectady
  - Syracuse
  - Utica
- (4) NORTH CAROLINA
  - Charlotte
  - Goldsboro
  - Hickory
  - Sanford
- (1) NORTH DAKOTA
  - Grand Forks
- (23) OHIO
  - Akron
  - Ashtabula
  - Cincinnati (3)
  - Columbus (3)
  - Dayton
  - Elyria
  - Hamilton
  - Mansfield
  - Niles
  - Sandusky
  - Tiffin
  - Toledo
  - Urbana
  - Wilmington
  - Zanesville
- (4) OKLAHOMA
  - Enid
  - Oklahoma City (2)
  - Tulsa
- (1) OREGON
  - Portland
- (30) PENNSYLVANIA
  - Allentown
  - Beaver Falls
  - Burgettstown
  - Coatesville
  - Connellsville
  - Dalton
  - Elizabeth
  - Erie
  - Harrisburg
  - Hellertown
  - Johnstown
  - Lancaster
  - Lewistown (2)
  - Monongahela
  - Natrona
  - Norristown
  - Philadelphia (4)
  - Pittsburgh (5)
  - Pottsville
  - Scranton
  - Verona
  - Williamsport
- (2) RHODE ISLAND
  - Providence (2)
- (2) SOUTH CAROLINA
  - Charleston
  - Greenville
- (1) SOUTH DAKOTA
  - Sioux Falls
- (2) TENNESSEE
  - Knoxville
  - Nashville
- (11) TEXAS
  - Abilene
  - Beaumont
  - Corpus Christi
  - Dallas
  - Fort Worth
  - Houston (3)
  - Longview
  - Port Arthur
  - Wichita Falls
- (1) UTAH
  - Salt Lake City
- (5) VIRGINIA
  - Alexandria
  - Chesapeake
  - Hopewell
  - Petersburgh
  - Winchester
- (2) WASHINGTON
  - Seattle (2)
- (3) WEST VIRGINIA
  - Charleston
  - Montgomery
  - Wheeling
- (5) WISCONSIN
  - Baraboo
  - Madison
  - Milwaukee (2)
  - Sheboygan
- (1) WYOMING
  - Rock Springs

Chilton Research Services
Philadelphia, Pennsylvania

Study #9545
December, 1970

Interview # ____________
(1-3)

FERROUS SCRAP INDUSTRY SURVEY

ASK FOR PRESIDENT, OWNER, OR GENERAL MANAGER.

INTRODUCTION: Good __________, I'm ______________ calling long distance from Chilton Research Services in Philadelphia for the Institute of Scrap Iron and Steel. The Institute, through its scrap metal research and education foundation and the Battelle Memorial Institute are conducting a study of the ferrous scrap industry under a grant from the U. S. Department of Health, Education, and Welfare. First . . .

Time Int. Began _____ A.M. _____ P.M.

Time Int. Ended _____ A.M. _____ P.M.

1. Which of the following types of scrap business activities does your firm engage in at this location? (READ LIST AND RECORD BELOW IN COL. A)

2. What percentage of your total revenue at this location is from (READ EACH ACTIVITY CIRCLED IN Q. 1). (RECORD IN COL. B)

		Q. 1 Col. A Engages In	Q. 2 Col. B %
	Iron and steel processor	4-1	(9-11)
	Iron and steel broker	5-1	(12-14)
	Nonferrous metal dealer	6-1	(15-17)
	Nonferrous metal broker	7-1	(18-20)
	Other (SPECIFY)	8-1	(21-23)
			100%
TERMINATE	None		

3. What is the area of your plant property? Please include all ground surrounding your building. (CIRCLE WHETHER ACRES OR SQUARE FEET)

Acres
______________________ Sq. Ft.

FOR OFFICE USE ONLY

Acres	24-1
Sq. Ft.	2

____
(25-30)

4. **Now, thinking of specific parts of your plant, how much of this area is used for . . .**
(READ EACH CATEGORY AND RECORD BELOW, CIRCLING WHETHER ACRES OR SQUARE FEET)

	Amount	Units	
		Sq. Ft.	Acres
Outdoor storage and processing	(31-39)	40-1	2
Storage and/or processing under roof	(41-49)	50-1	2
Offices	(51-59)	60-1	2
Other (PLEASE SPECIFY) ____________________	(61-69)	70-1	2

(ASK Q.'S 5 AND Q. 6 IN ORDER, AS APPLICABLE, FOR EACH ITEM.) End of Card #1 (80-1)

5. I'm now going to read a list of different types of equipment. Please tell me . . . do you have a (ITEMS IN COL. A)? (RECORD IN COL. B)

6. (FOR EACH CIRCLED IN COL. B) How many (ITEMS CIRCLED) do you have? (RECORD IN COL. C)

	Q. 5	Q. 6
	Col. B	Col. C
Col. A	Have this item (CIRCLE)	Number
Baler or press	4-1	(5-7)
R. R. siding	8-1	(9-11)
Shredder	12-1	(13-15)
Alligator-Shear	16-1	(17-19)
Guillotine-Shear	20-1	(21-23)
Fork lift	24-1	(25-27)
Turnings crusher	28-1	(29-31)
Incinerator	32-1	(33-35)
Trucks	36-1	(37-39)
Cranes	40-1	(41-43)
Car flattener	44-1	(45-47)
Briquetter	48-1	(49-51)
Furnaces	52-1	(53-55)
Magnets	56-1	(57-59)
Other (SPECIFY)	60-1	(61-63)
TOTAL	▨	

(ASK Q. 7 ONLY IF "BALER OR PRESS" IS CIRCLED IN COL. B -- OTHERWISE, SKIP TO Q. 8)

7. (IF "BALER OR PRESS" IN Q. 5, ASK:) Will your baler handle a complete auto hulk?

Yes	64-1
No	2

8. Would you say that most of your scrap processing equipment is:

(CIRCLE ONE ONLY)

Less than 5 years old	65-1
5 - 10 years old	2
10 - 20 years old	3
Over 20 years old	4

End of Card 2 (80-2)

(ASK Q.'s 9 THRU 10a IN ORDER, AS APPLICABLE FOR EACH ITEM)

9. Now, please tell me, at present is raw material delivered to your yard by (METHODS IN COL. A)? (RECORD IN COL. B)

9a. Was it delivered by (METHODS) 5 years ago? (RECORD IN COL. C)

10. (FOR EACH CIRCLED IN COL. B) What % of your raw material to your yard at present is delivered by (METHOD CIRCLED IN COL. B)? (RECORD IN COL. D)

10a. (FOR EACH CIRCLED IN COL. C) What percentage of your raw material was delivered to your yard 5 years ago by (METHODS IN COL. C)? (RECORD IN COL. E)

Col. A Method	Q. 9 Col. B CIRCLE IF USED Today	Q. 9a Col. C CIRCLE IF USED 5 yrs. ago	Q. 10 Col. D % IF USED Today	Q. 10a Col. E % IF USED 5 yrs. ago
Rail	4-1	5-1	(6-8)	(9-11)
Truck	12-1	13-1	(14-16)	(17-19)
Barge	20-1	21-1	(22-24)	(25-27)
Other (SPECIFY)	28-1	29-1	(30-32)	(33-35)
			100%	100%

(IF INDICATED COLUMNS DO NOT ADD UP TO 100%, ASK RESPONDENT TO CORRECT TOTALS.)

11. (IF THERE IS A DIFFERENCE BETWEEN TODAY'S PERCENTAGE AND THAT OF 5 YEARS AGO FOR A PARTICULAR METHOD, CIRCLE WHETHER INCREASE OR DECREASE AND ASK:) Why has the percentage delivered by . . . (METHOD INDICATING DIFFERENCE) increased (decreased)? (CONTINUE FOR EACH METHOD WHERE THE PERCENT HAS CHANGED.)

Method	Col. A Increase	Col. B Decrease	Reason Why
Rail	36-1	2	(37)
Truck	38-1	2	(39)
Barge	40-1	2	(41)
Other (SPECIFY)	42-1	2	(43)

12. At present, from how wide a radius can you economically obtain raw materials?

_______________ miles
(44-47)

13. From how wide a radius could you economically obtain raw material 5 years ago?

_______________ miles
(48-51)

14. (IF THERE IS A DIFFERENCE BETWEEN THE ANSWERS TO Q. 11 AND Q. 12, ASK:) Why has this radius increased/decreased?

(52)

15. From what cities do you now obtain most of your normal supply of raw material? (FOR EACH, ASK: CITY AND STATE -- RECORD BELOW)

	City	State
(53-54)		
(55-56)		
(57-58)		

16. Now, thinking of the sources of raw material, that is, industrial and obsolescence, please tell me what percent of your raw material you receive from industrial sources? (RECORD BELOW)

16a. What percent do you receive from obsolescence sources? (RECORD BELOW)

Industrial Sources ________ % + Obsolescence Sources ________ % = 100%
59-60 61-62

17. Now, thinking of industrial sources as 100%, what percent is derived from the auto industry . . . what percent is derived from other industry?

Industrial Sources	%
Auto industry	63-64
Other industry	65-66
	100%

17a. Thinking of the obsolete source as 100%, what percent is derived from automobiles, appliances, or railroads?

Obsolete Sources	%
Automobiles	67-68
Appliances	69-70
Railroads	71-72
Other (SPECIFY)	73-74
	100%

End of Card #3 80-3

18. At present, within how wide a radius can you economically ship your output of scrap?

_______________ miles
(4-7)

19. Within how wide a radius could you economically ship your output of scrap 5 years ago?

_______________ miles
(8-11)

20. To what cities do you now ship most of your output of scrap? (ASK FOR CITY AND STATE)

	City	State
(12-13)		
(14-15)		
(16-17)		

(ASK Q.'s 21 AND 22 IN ORDER, AS APPLICABLE, FOR EACH TYPE OF SCRAP LISTED IN COL. A)

21. Now, I'm going to read several types of processed scrap metal. Do you ship (TYPES OF SCRAP) from your plant? (RECORD IN COL. B)

22. (IF "SHIPPED") Approximately how many tons of (EACH TYPE SHIPPED) scrap do you ship in an average month? (RECORD IN COL. C)

	Q. 21	Q. 22
Col. A	Col. B	Col. C
Types of Scrap	If Shipped (CIRCLE)	Average Tonnage Per Month
Cast iron	18-1	(19-24)
Stainless steel	25-1	(26-31)
Alloy steel	32-1	(33-38)
All heavy melting steel	39-1	(40-45)
No. 1 and electric furnace bundles	46-1	(47-52)
No. 2 and all other bundles	53-1	(54-59)
Nonferrous	60-1	(61-66)
Other major categories (SPECIFY)	67-1	(68-73)

End of Card 4 (80-4)

(ASK Q.'s 23 THRU 24a IN ORDER, AS APPLICABLE, FOR EACH ITEM)

23. Please tell me, do you, at present ship processed scrap by (METHODS IN COL. A)? (RECORD IN COL. B)

23a. Was it shipped by (METHODS) 5 years ago? (RECORD IN COL. C)

24. (FOR EACH CIRCLED IN COL. B) What percent of your processed scrap is shipped at present by (METHOD CIRCLED IN COL. B)? (RECORD IN COL. D)

24a. (FOR EACH CIRCLED IN COL. C) What percent of your processed scrap was shipped by (METHODS IN COL. C) 5 years ago? (RECORD IN COL. E)

Col. A Methods	Q. 23 Col. B If Yes Today	Q. 23a Col. C If Yes 5 yrs. ago	Q. 24 Col. D % Today	Q. 24a Col. E % 5 yrs. ago
Rail	4-1	5-1	(6-8)	(9-11)
Truck	12-1	13-1	(14-16)	(17-19)
Barge	20-1	21-1	(22-24)	(25-27)
Other (SPECIFY)	28-1	29-1	(30-32)	(33-35)
			100%	100%

25. (FOR EACH METHOD WHERE THERE IS A DIFFERENCE BETWEEN TODAY'S PERCENTAGE AND THAT OF 5 YEARS AGO, ASK:) Why has the percentage shipped by . . . (METHOD INDICATING DIFFERENCE) increased/decreased? (CONTINUE FOR EACH METHOD WHERE THE PERCENT HAS CHANGED)

Method	Col. A Increase	Col. B Decrease	Reason Why
Rail	36-1	2	(37)
Truck	38-1	2	(39)
Barge	40-1	2	(41)
Other (SPECIFY)	42-1	2	(43)

(ASK Q.'s 26 AND 27 IN ORDER, AS APPLICABLE, FOR EACH ITEM)

26. Do you ship your processed scrap to (ITEM IN COL. A)? (RECORD IN COL. B)

27. (IF "SHIPPED") What percent of your processed scrap is shipped to (ITEMS SHIPPED IN COL. B)? (RECORD IN COL. C)

	Q. 26	Q. 27
	Col. B	Col. C
Col. A	Is Shipped (CIRCLE)	%
Steel mills	44-1	(45-47)
Foundries	48-1	(49-51)
Other processors or brokers	52-1	(53-55)
Any other (SPECIFY)	56-1	(57-59)
		100%

End of Card 5 (80-5)

28. What solid wastes or nonmarketable residues do you have to dispose of? (RECORD IN COL. A)

29. How do you dispose of your (WASTE IN COL. A)? (RECORD IN COL. B)

30. (IF NOT ANSWERED IN Q. 29) Who disposes of it? (RECORD IN COL. C)

31. How much does it cost you to dispose of the __________? (RECORD IN COL. D)

(IF RESPONDENT SAYS, "We do it ourselves", SAY; "Well, how much would you say it costs you?") (RECORD IN COL. D)

Q. 28	Q. 29	Q. 30	Q. 31
Col. A	Col. B	Col. C	Col. D
Type of Nonmarketable Solid Waste	Method of Disposal	By Whom	Cost

End of Card 6 (80-6)

32. I'm going to read a list of factors important in determining your current or planned volume of business or operating level. In your opinion, which one of the following is the most important factor in determining this:

(CIRCLE ONE ONLY)

Availability of raw material	4-1
Dollar differential between your raw material cost and scrap prices	2
Capacity of your processing facilities	3
Other (PLEASE SPECIFY)	0

33. Now, I'm going to read a list of four costs. I'd like you to rank them in the order of their relative importance as a percentage of your total costs; "1" being the most important or having the highest percentage of your total costs, and "4" being the least important or having the lowest percentage of your total costs. (READ ENTIRE LIST FIRST, THEN OBTAIN AND RECORD RANKING)

		Rank
Labor costs	5-	
Raw material costs	6-	
Transportation costs	7-	
Financial costs	8-	

34. What would you say is the most serious problem facing you as a businessman in the scrap industry?

____ (9-10)

____

____

. . . Any other problem you consider important?

____

____

35. What in your opinion is the most serious problem facing the scrap industry as a whole?

____ (11-12)

____

____

. . . Any other industrywide problem you consider important?

____

____

36. What would you say can and/or should be done to alleviate these problems?

1. ____ (13-14)
2. ____ (15-16)
3. ____ (17-18)

Now, so that we may group your comments, please tell me:

37. I'm going to read a list of categories. Please tell me which one best describes your total revenue for 1969 at this location? (READ CATEGORIES AND CIRCLE ANSWER)

Less than $500,000	19-1
$500,000 to $1 million	2
$1 to $3 million	3
$3 to $5 million	4
$5 to $7 million	5
$7 to $10 million	6
$10 to $15 million	7
Over $15 million	8

38. How many employees do you now have at this location?

________________________________ (20-23)

39. How many of these are foreman or higher?

________________________________ (24-28)

40. How many hours does your plant normally operate each week? (ACCEPTABLE ANSWERS MAY INCLUDE NUMBER OF SHIFTS PER DAY, AND NUMBER DAYS PER WEEK.)

________________________ hours per week (29-31)

41. Again, I'm going to read a list of categories. Please tell me which one best describes your total capital investment in plant and equipment -- at cost? (IF ORIGINAL COST UNKNOWN ASK FOR REPLACEMENT COST AND INDICATE WITH AN "R")

Less than $250,000	32-1
$250,000 to $500,000	2
$500,000 to $1 million	3
$1 to $2 million	4
$2 to $4 million	5
$4 to $7 million	6
$7 to $10 million	7
Over $10 million	8

42. Are there any company locations other than this one? (IF "YES", RECORD CITY AND STATE BELOW)

City ______ State ______

City ______ State ______

THANK YOU VERY MUCH. IT WAS A PLEASURE TALKING TO YOU AND GETTING YOUR COMMENTS. DO HAVE A GOOD DAY.

COMPANY NAME ______

STREET ADDRESS ______

CITY ______ (33-34) STATE ______ (35-36) ZIP ______

PHONE: ______ Area Code ______ Number

RESPONDENT: Name ______

Title ______

ISIS	Member - Sample	37-1
ISIS	Member - Alternate	2
ISIS	Nonmember - Sample	3
ISIS	Nonmember - Alternate	4

End of Card 7 (80-7)

ABSOLUTE TALLY CLASSIFIED BY BASIC ANSWERS TO QUESTIONS IN TERMS OF REGION FOR ALL COMPANIES CALLED

	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
TOTAL COUNT	247	1	18	57	31	64	18	16	19	2	21	0
IRON AND STEEL PROCESSOR	197	1	12	47	26	49	13	16	16	2	15	0
UNKNOWN PERCENT	1	0	0	0	0	0	0	1	0	0	0	0
LESS THAN 26 PERCENT	30	0	6	4	5	3	1	4	2	0	5	0
26 TO 50 PERCENT	54	1	2	11	7	14	2	5	7	1	4	0
51 TO 75 PERCENT	55	0	3	12	11	10	8	5	4	0	2	0
76 TO 99 PERCENT	46	0	1	15	2	20	2	1	2	1	2	0
100 PERCENT	11	0	0	5	1	2	0	0	1	0	2	0
IRON AND STEEL BROKER	78	1	4	15	7	23	6	8	4	0	10	0
UNKNOWN PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
LESS THAN 26 PERCENT	66	1	4	14	6	17	4	7	4	0	9	0
26 TO 50 PERCENT	8	0	0	1	1	4	0	1	0	0	1	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
76 TO 99 PERCENT	2	0	0	0	0	1	1	0	0	0	0	0
100 PERCENT	2	0	0	0	0	1	1	0	0	0	0	0
NONFERROUS METAL DEALER	201	1	15	43	27	50	16	15	17	2	15	0
UNKNOWN PERCENT	1	0	0	0	0	0	0	0	1	0	0	0
LESS THAN 26 PERCENT	100	0	6	24	13	30	9	7	5	1	5	0
26 TO 50 PERCENT	61	1	5	11	10	11	4	6	8	0	5	0
51 TO 75 PERCENT	17	0	0	3	3	6	0	2	0	1	2	0
76 TO 99 PERCENT	12	0	3	3	1	1	2	0	1	0	1	0
100 PERCENT	10	0	1	2	0	2	1	0	2	0	2	0
NONFERROUS METAL BROKER	57	1	6	8	7	12	3	5	5	0	10	0
UNKNOWN PERCENT	1	0	0	0	0	0	1	0	0	0	0	0
LESS THAN 26 PERCENT	48	1	4	8	6	9	2	4	5	0	9	0
26 TO 50 PERCENT	5	0	0	0	1	2	0	1	0	0	1	0
51 TO 75 PERCENT	1	0	0	0	0	1	0	0	0	0	0	0
76 TO 99 PERCENT	2	0	2	0	0	0	0	0	0	0	0	0
100 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
OTHER ACTIVITY	50	0	5	8	8	12	2	3	4	1	7	0
UNKNOWN PERCENT	2	0	0	1	1	0	0	0	0	0	0	0
LESS THAN 26 PERCENT	28	0	3	4	4	8	2	1	3	1	2	0
26 TO 50 PERCENT	11	0	0	3	1	3	0	2	0	0	2	0
51 TO 75 PERCENT	5	0	1	0	2	0	0	0	1	0	1	0
76 TO 99 PERCENT	1	0	0	0	0	0	0	0	0	0	1	0
100 PERCENT	3	0	1	0	0	1	0	0	0	0	1	0
IRON AND STEEL PROC/BROKER	203	1	12	48	26	51	15	16	16	2	16	0
UNKNOWN PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
LESS THAN 26 PERCENT	26	0	5	5	5	2	1	3	2	0	3	0
26 TO 50 PERCENT	48	1	3	7	6	11	2	5	6	1	6	0
51 TO 75 PERCENT	54	0	3	12	10	8	8	5	5	0	3	0
76 TO 99 PERCENT	54	0	1	16	4	23	3	2	2	1	2	0
100 PERCENT	21	0	0	8	1	7	1	1	1	0	2	0
TOTAL AREA OF PLANT	247	1	18	57	31	64	18	16	19	2	21	0
AREA UNKNOWN	3	0	0	1	0	2	0	0	0	0	0	0
LESS THAN 1 ACRE	21	0	5	7	1	2	3	1	2	0	0	0
1 TO 5 ACRES	105	0	12	24	16	21	4	9	8	1	10	0
6 TO 10 ACRES	59	0	1	11	6	25	3	2	7	0	4	0
MORE THAN 10 ACRES	59	1	0	14	8	14	8	4	2	1	7	0
AREA OF OUTDOOR STORAGE+PROC	247	1	18	57	31	64	18	16	19	2	21	0

ABSOLUTE TALLY CLASSIFIED BY BASIC ANSWERS TO QUESTIONS IN TERMS OF REGION FOR ALL COMPANIES CALLED

	TOTAL	UN- KNOWN	NEW ENG- LAND	MID- DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN- TRAL	EAST SOUTH CEN- TRAL	WEST NORTH CEN- TRAL	WEST SOUTH CEN- TRAL	MOUN- TAIN	PAC- IFIC	OUTSID UNI- TED STATE
AREA UNKNOWN	19	0	4	4	3	4	3	0	1	0	0	0
LESS THAN 1 ACRE	46	0	3	14	6	8	5	4	3	0	3	0
1 TO 5 ACRES	100	0	11	23	11	22	4	8	9	1	11	0
6 TO 10 ACRES	52	0	0	12	6	19	3	1	6	0	5	0
MORE THAN 10 ACRES	30	1	0	4	5	11	3	3	0	1	2	0
AREA STORAGE+PROC UNDER ROOF	247	1	18	57	31	64	18	16	19	2	21	0
UNKNOWN AREA	37	0	0	13	6	9	1	1	3	0	4	0
LESS THAN 5000 SQUARE FEET	29	0	2	12	1	4	6	1	2	0	1	0
5001 TO 10,000 SQUARE FEET	29	0	2	9	0	10	2	2	2	0	2	0
10.001 TO 25.000 SQUARE FEET	71	0	11	11	11	20	4	1	7	1	5	0
25.001 TO 50.000 SQUARE FEET	40	0	2	8	7	8	2	6	4	0	3	0
MORE THAN 50.000 SQUARE FEET	41	1	1	4	6	13	3	5	1	1	6	0
AREA OF OFFICES	247	1	18	57	31	64	18	16	19	2	21	0
UNKNOWN AREA	60	0	4	17	9	14	2	3	6	1	4	0
LESS THAN 5000 SQUARE FEET	118	0	10	33	13	27	11	9	10	1	4	0
5001 TO 10,000 SQUARE FEET	15	0	0	3	0	5	2	1	2	0	2	0
10,001 TO 25,000 SQUARE FEET	32	0	4	2	5	9	2	1	1	0	8	0
25,001 TO 50,000 SQUARE FEET	13	0	0	2	2	5	0	2	0	0	2	0
MORE THAN 50,000 SQUARE FEET	9	1	0	0	2	4	1	0	0	0	1	0
AREA OF OTHER FACILITIES	247	1	18	57	31	64	18	16	19	2	21	0
UNKNOWN AREA	215	1	17	52	29	55	13	16	15	2	15	0
LESS THAN 5000 SQUARE FEET	3	0	1	1	0	1	0	0	0	0	0	0
5001 TO 10,000 SQUARE FEET	2	0	0	0	0	2	0	0	0	0	0	0
10,001 TO 25,000 SQUARE FEET	7	0	0	0	0	2	2	0	1	0	2	0
25,001 TO 50,000 SQUARE FEET	3	0	0	1	0	1	0	0	1	0	0	0
MORE THAN 50,000 SQUARE FEET	17	0	0	3	2	3	3	0	2	0	4	0
HAVE BALER OR PRESS	186	1	15	44	27	43	14	9	16	1	16	0
ONLY ONE	122	0	9	28	21	29	9	7	8	1	10	0
TWO TO FIVE	62	1	5	16	5	14	5	2	8	0	6	0
SIX TO TEN	1	0	0	0	1	0	0	0	0	0	0	0
MORE THAN TEN	1	0	1	0	0	0	0	0	0	0	0	0
HAVE RAILROAD SIDING	199	1	10	44	25	55	13	15	17	2	17	0
ONLY ONE	111	0	7	30	16	31	4	5	9	1	8	0
TWO TO FIVE	82	1	3	11	9	23	7	10	8	1	9	0
SIX TO TEN	4	0	0	3	0	0	1	0	0	0	0	0
MORE THAN TEN	2	0	0	0	0	1	1	0	0	0	0	0
HAVE SHREDDER	21	1	1	3	1	6	2	2	1	0	4	0
ONLY ONE	16	1	0	2	1	4	2	2	1	0	3	0
TWO TO FIVE	5	0	1	1	0	2	0	0	0	0	1	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE ALLIGATOR-SHEAR	206	1	15	49	26	52	14	15	14	2	18	0
ONLY ONE	90	0	8	21	16	19	6	7	5	1	7	0
TWO TO FIVE	114	1	7	28	10	32	7	8	9	1	11	0
SIX TO TEN	2	0	0	0	0	1	1	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE CUILLOTINE-SHEAR	98	1	1	21	13	25	8	9	11	1	8	0
ONLY ONE	90	1	1	18	12	23	7	9	10	1	8	0
TWO TO FIVE	8	0	0	3	1	2	1	0	1	0	0	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0

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	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE FORK LIFT	188	1	16	40	21	48	14	13	13	2	20	0
ONLY ONE	66	0	6	13	7	20	4	6	4	2	4	0
TWO TO FIVE	98	1	9	22	10	25	8	6	8	0	9	0
SIX TO TEN	18	0	1	4	3	2	2	0	1	0	5	0
MORE THAN TEN	6	0	0	1	1	1	0	1	0	0	2	0
HAVE TURNINGS CRUSHER	32	1	0	6	3	13	2	1	1	0	5	0
ONLY ONE	27	1	0	3	2	12	2	1	1	0	5	0
TWO TO FIVE	5	0	0	3	1	1	0	0	0	0	0	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE INCINERATOR	42	1	1	8	6	9	3	4	3	0	7	0
ONLY ONE	39	1	1	8	5	7	3	4	3	0	7	0
TWO TO FIVE	3	0	0	0	1	2	0	0	0	0	0	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE TRUCKS	231	1	18	52	29	60	16	16	18	2	19	0
ONLY ONE	11	0	1	4	3	1	1	1	0	0	0	0
TWO TO FIVE	102	0	6	29	16	20	5	9	7	0	10	0
SIX TO TEN	72	0	7	9	6	25	6	4	9	1	5	0
MORE THAN TEN	46	1	4	10	4	14	4	2	2	1	4	0
HAVE CRANES	213	1	10	51	29	56	13	16	17	2	18	0
ONLY ONE	39	0	0	13	6	9	2	2	4	2	1	0
TWO TO FIVE	123	0	10	23	19	32	6	11	8	0	14	0
SIX TO TEN	46	1	0	13	3	13	5	3	5	0	3	0
MORE THAN TEN	5	0	0	2	1	2	0	0	0	0	0	0
HAVE CAR FLATTENER	15	1	1	1	1	5	2	2	1	0	1	0
ONLY ONE	15	1	1	1	1	5	2	2	1	0	1	0
TWO TO FIVE	0	0	0	0	0	0	0	0	0	0	0	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE BRIQUETTER	49	1	4	10	4	14	6	1	5	0	4	0
ONLY ONE	41	1	3	8	4	11	6	1	4	0	3	0
TWO TO FIVE	7	0	1	2	0	2	0	0	1	0	1	0
SIX TO TEN	1	0	0	0	0	1	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE FURNACES	48	1	2	4	4	12	6	6	5	0	8	0
ONLY ONE	37	0	1	4	2	9	4	5	5	0	7	0
TWO TO FIVE	11	1	1	0	2	3	2	1	0	0	1	0
SIX TO TEN	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN TEN	0	0	0	0	0	0	0	0	0	0	0	0
HAVE MAGNETS	204	1	9	52	28	54	13	12	16	1	18	0
ONLY ONE	43	0	0	17	8	8	2	1	5	1	1	0
TWO TO FIVE	119	0	8	23	16	32	8	9	10	0	13	0
SIX TO TEN	37	1	1	11	4	10	3	2	1	0	4	0
MORE THAN TEN	5	0	0	1	0	4	0	0	0	0	0	0
HAVE OTHER	45	0	3	11	3	13	2	5	6	2	0	0
ONLY ONE	18	0	1	3	2	4	0	3	5	0	0	0
TWO TO FIVE	20	0	2	8	1	5	1	1	1	1	0	0
SIX TO TEN	2	0	0	0	0	0	0	1	0	1	0	0

ABSOLUTE TALLY CLASSIFIED BY BASIC ANSWERS TO QUESTIONS IN TERMS OF REGION FOR ALL COMPANIES CALLED

	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
MORE THAN TEN	5	0	0	0	0	4	1	0	0	0	0	0
HAVE BALER OR PRESS	186	1	15	44	27	43	14	9	16	1	16	0
UNKNOWN	1	0	0	0	0	0	0	0	1	0	0	0
HANDLES AUTO HULK	60	0	2	15	8	19	4	2	6	0	4	0
DOES NOT HANDLE AUTO HULK	125	1	13	29	19	24	10	7	9	1	12	0
AGE OF PROCESSING EQUIPMENT	243	1	17	57	31	62	17	16	19	2	21	0
LESS THAN FIVE YEARS	45	0	5	9	3	15	2	3	4	0	4	0
FIVE TO TEN YEARS	113	1	7	22	16	26	12	6	12	1	10	0
TEN TO TWENTY YEARS	77	0	4	24	11	19	3	7	3	1	5	0
OVER TWENTY YEARS	8	0	1	2	1	2	0	0	0	0	2	0
MATERIAL DELIVERED BY RAIL	140	1	6	25	15	45	9	13	11	1	14	0
USES RAIL TODAY	130	1	4	23	14	43	9	13	9	1	13	0
LESS THAN 26 PERCENT	97	1	4	18	11	31	6	12	7	1	6	0
26 TO 50 PERCENT	16	0	0	3	1	4	1	0	2	0	5	0
51 TO 75 PERCENT	5	0	0	0	2	1	1	0	0	0	1	0
MORE THAN 75 PERCENT	12	0	0	2	0	7	1	1	0	0	1	0
USED RAIL 5 YEARS AGO	131	1	6	23	12	41	9	13	11	1	14	0
LESS THAN 26 PERCENT	95	1	3	17	10	30	6	12	9	1	6	0
26 TO 50 PERCENT	19	0	2	5	1	4	1	0	2	0	4	0
51 TO 75 PERCENT	8	0	0	0	1	3	1	0	0	0	3	0
MORE THAN 75 PERCENT	9	0	1	1	0	4	1	1	0	0	1	0
MATERIAL DELIVERED BY TRUCK	238	1	18	55	31	59	17	15	19	2	21	0
USES TRUCK TODAY	238	1	18	55	31	59	17	15	19	2	21	0
LESS THAN 26 PERCENT	13	0	0	2	2	6	1	0	0	0	2	0
26 TO 50 PERCENT	11	0	0	1	2	4	2	0	0	0	2	0
51 TO 75 PERCENT	16	0	1	4	0	3	1	1	2	0	4	0
MORE THAN 75 PERCENT	198	1	17	48	27	46	13	14	17	2	13	0
USED TRUCK 5 YEARS AGO	227	1	17	53	27	55	17	15	19	2	21	0
LESS THAN 26 PERCENT	10	0	0	1	2	4	1	0	0	0	2	0
26 TO 50 PERCENT	17	0	2	1	1	6	1	0	1	0	5	0
51 TO 75 PERCENT	19	0	0	6	0	5	2	2	2	0	2	0
MORE THAN 75 PERCENT	181	1	15	45	24	40	13	13	16	2	12	0
MATERIAL DELIVERED BY BARGE	4	0	0	0	0	1	3	0	0	0	0	0
USES BARGE TODAY	3	0	0	0	0	1	2	0	0	0	0	0
LESS THAN 26 PERCENT	3	0	0	0	0	1	2	0	0	0	0	0
26 TO 50 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
USED BARGE 5 YEARS AGO	3	0	0	0	0	1	2	0	0	0	0	0
LESS THAN 26 PERCENT	3	0	0	0	0	1	2	0	0	0	0	0
26 TO 50 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MATRL DELIVERED BY OTHER MODE	5	0	0	0	2	1	0	0	0	1	1	0
USED OTHER MODE TODAY	5	0	0	0	2	1	0	0	0	1	1	0
LESS THAN 26 PERCENT	4	0	0	0	1	1	0	0	0	1	1	0
26 TO 50 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	1	0	0	0	1	0	0	0	0	0	0	0
USED OTHER MODE 5 YEARS AGO	5	0	0	0	2	1	0	0	0	1	1	0

ABSOLUTE TALLY CLASSIFIED BY BASIC ANSWERS TO QUESTIONS IN TERMS OF REGION FOR ALL COMPANIES CALLED

	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
LESS THAN 26 PERCENT	4	0	0	0	1	1	0	0	0	1	1	0
26 TO 50 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	1	0	0	0	1	0	0	0	0	0	0	0
RADIUS MATERIAL OBTAINED /	242	1	18	56	30	63	17	16	19	2	20	0
0-50 MILES	121	0	8	38	21	32	3	5	8	1	5	0
51 TO 100 MILES	59	0	7	7	6	18	7	5	4	0	5	0
101 TO 200 MILES	30	0	1	4	1	7	5	2	4	0	6	0
201 TO 300 MILES	12	0	0	2	0	3	2	3	1	0	1	0
301 TO 400 MILES	1	0	0	0	0	1	0	0	0	0	0	0
401 TO 500 MILES	4	0	1	0	0	1	0	0	0	1	1	0
501 TO 750 MILES	2	0	0	0	0	0	0	1	1	0	0	0
MORE THAN 750 MILES	13	1	1	5	2	1	0	0	1	0	2	0
RADIUS MATRL OBTAIN 5 YRS AGO	234	1	17	55	27	60	17	16	19	2	20	0
0-50 MILES	105	0	6	34	18	31	4	2	5	1	4	0
51 TO 100 MILES	60	0	7	9	7	13	7	6	7	0	4	0
101 TO 200 MILES	29	0	1	4	1	7	3	3	3	0	7	0
201 TO 300 MILES	16	0	0	3	0	5	1	3	2	0	2	0
301 TO 400 MILES	4	0	0	1	0	2	1	0	0	0	0	0
401 TO 500 MILES	7	0	2	1	0	1	1	0	0	1	1	0
501 TO 750 MILES	2	0	0	0	0	0	0	1	1	0	0	0
MORE THAN 750 MILES	11	1	1	3	1	1	0	1	1	0	2	0
REGION MATERIAL OBTAINED	247	1	18	57	31	64	18	16	19	2	21	0
UNKNOWN	1	1	0	0	0	0	0	0	0	0	0	0
NEW ENGLAND	18	0	14	0	0	0	0	0	0	0	0	0
MIDDLE ATLANTIC	57	0	0	57	0	0	0	0	0	0	0	0
SOUTH ATLANTIC	31	0	0	0	31	0	0	0	0	0	0	0
EAST NORTH CENTRAL	64	0	0	0	0	64	0	0	0	0	0	0
EAST SOUTH CENTRAL	18	0	0	0	0	0	18	0	0	0	0	0
WEST NORTH CENTRAL	16	0	0	0	0	0	0	16	0	0	0	0
WEST SOUTH CENTRAL	19	0	0	0	0	0	0	0	19	0	0	0
MOUNTAIN	2	0	0	0	0	0	0	0	0	2	0	0
PACIFIC	21	0	0	0	0	0	0	0	0	0	21	0
OUTSIDE UNITED STATES	0	0	0	0	0	0	0	0	0	0	0	0
MATRL FROM INDUSTRIAL SOURCE	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	60	0	4	15	7	6	4	5	8	0	11	0
26 TO 50 PERCENT	61	0	2	9	12	16	6	6	4	1	5	0
51 TO 75 PERCENT	46	1	5	8	6	14	3	2	3	0	4	0
MORE THAN 75 PERCENT	67	0	7	18	5	26	4	3	3	0	1	0
NONE FROM INDUSTRY	13	0	0	7	1	2	1	0	1	1	0	0
MATRL FROM OBSOLETE SOURCE	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	66	0	11	14	5	23	3	3	3	0	4	0
26 TO 50 PERCENT	58	1	2	11	10	18	5	5	1	1	4	0
51 TO 75 PERCENT	46	0	2	6	9	7	5	1	10	0	6	0
MORE THAN 75 PERCENT	51	0	2	18	5	6	4	5	3	1	7	0
NONE FROM OBSOLETE SOURCE	24	0	1	8	1	9	1	2	2	0	0	0
IF FROM INDUSTRY	247	1	18	57	31	64	18	16	19	2	21	0
MATRL FROM AUTO INDUSTRY	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	71	1	5	19	6	20	2	2	4	1	11	0
26 TO 50 PERCENT	26	0	0	6	5	12	1	0	1	0	1	0

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	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
51 TO 75 PERCENT	13	0	1	2	4	4	2	0	0	0	0	0
MORE THAN 75 PERCENT	11	0	2	1	0	6	1	0	0	0	1	0
NONE FROM AUTO INDUSTRY	126	0	10	29	16	22	12	14	14	1	8	0
MATRL FROM OTHER INDUSTRY	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	12	0	3	1	1	5	1	0	0	0	1	0
26 TO 50 PERCENT	21	0	0	3	4	10	3	0	1	0	0	0
51 TO 75 PERCENT	21	0	1	5	5	8	0	0	0	0	2	0
MORE THAN 75 PERCENT	179	1	14	44	20	35	13	16	17	1	18	0
NONE FROM OTHER INDUSTRY	14	0	0	4	1	6	1	0	1	1	0	0
IF FROM OBSOLETE SOURCE	247	1	18	57	31	64	18	16	19	2	21	0
MATRL FROM AUTO INDUSTRY	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	48	0	3	14	5	14	2	1	3	0	6	0
26 TO 50 PERCENT	54	0	3	14	2	15	5	5	4	2	4	0
51 TO 76 PERCENT	48	1	2	7	8	11	3	5	6	0	5	0
MORE THAN 75 PERCENT	34	0	3	11	9	3	4	1	2	0	1	0
NONE FROM AUTO INDUSTRY	63	0	7	11	7	21	4	4	4	0	5	0
MATRL FROM APPLIANCES	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	93	1	2	26	10	24	4	7	10	0	7	0
26 TO 50 PERCENT	20	0	2	3	2	6	1	0	1	0	5	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	8	0	1	2	0	2	0	1	0	0	2	0
NONE FROM APPLIANCES	126	0	13	26	19	30	13	8	8	2	7	0
MATRL FROM RAILROADS	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	67	1	1	15	9	20	6	4	7	0	4	0
26 TO 50 PERCENT	15	0	2	3	0	5	2	0	1	1	1	0
51 TO 75 PERCENT	2	0	0	0	0	0	1	0	0	0	1	0
MORE THAN 75 PERCENT	6	0	0	0	0	3	0	1	0	0	2	0
NONE FROM RAILROADS	157	0	15	39	22	36	9	11	11	1	13	0
MATRL FROM OTHER SOURCE	247	1	18	57	31	64	18	16	19	2	21	0
LESS THAN 26 PERCENT	39	0	4	7	5	6	5	5	4	0	3	0
26 TO 50 PERCENT	36	1	1	11	4	9	2	2	1	1	4	0
51 TO 75 PERCENT	28	0	2	11	1	7	0	3	2	0	2	0
MORE THAN 75 PERCENT	42	0	6	5	8	11	5	1	4	0	2	0
NONE FROM OTHER SOURCE	102	0	5	23	13	31	6	5	8	1	10	0
RADIUS SCRAP SHIPPPED	226	1	15	54	29	56	16	14	19	2	20	0
0-50 MILES	37	0	2	12	6	4	2	3	2	0	6	0
51 TO 100 MILES	45	0	6	16	3	11	0	0	3	1	5	0
101 TO 200 MILES	40	0	1	8	8	13	5	1	1	0	3	0
201 TO 300 MILES	27	0	1	1	6	10	1	2	5	0	1	0
301 TO 400 MILES	12	0	1	1	2	2	3	2	1	0	0	0
401 TO 500 MILES	18	0	2	4	0	8	1	2	1	0	0	0
501 TO 750 MILES	11	0	0	3	0	4	1	2	1	0	0	0
MORE THAN 750 MILES	36	1	2	9	4	4	3	2	5	1	5	0
RADIUS SCRAP SHIPED 5 YRS AGO	220	1	14	52	27	55	16	14	19	2	20	0
0-50 MILES	36	0	1	12	7	4	1	2	2	0	7	0
51 TO 100 MILES	34	0	4	10	1	11	1	1	1	1	4	0
101 TO 200 MILES	45	0	1	11	8	14	6	1	2	0	2	0
201 TO 300 MILES	22	0	0	2	4	11	0	2	2	0	1	0
301 TO 400 MILES	11	0	1	1	1	1	2	2	2	0	1	0
401 TO 500 MILES	18	0	3	3	2	4	2	3	1	0	0	0

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	TOTAL	UN- KNOWN	NEW ENG- LAND	MID- DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN- TRAL	EAST SOUTH CEN- TRAL	WEST NORTH CEN- TRAL	WEST SOUTH CEN- TRAL	MOUN- TAIN	PAC- IFIC	OUTSID UNI- TED STATE
501 TO 750 MILES	13	0	1	4	0	5	1	2	0	0	0	0
MORE THAN 750 MILES	41	1	3	9	4	5	3	1	9	1	5	0
CAST IRON SHIPPED PER MONTH	167	1	10	31	21	42	14	13	16	2	17	0
LESS THAN 100 TONS	95	0	7	21	14	23	6	6	6	2	10	0
101 TO 500	57	1	1	9	6	15	5	7	8	0	5	0
501 TO 1000	8	0	0	1	1	3	1	0	1	0	1	0
1001 TO 2500	2	0	0	0	0	0	2	0	0	0	0	0
2501 TO 5000	3	0	1	0	0	1	0	0	0	0	1	0
5001 TO 10000	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 10000	2	0	1	0	0	0	0	0	1	0	0	0
STAINLESS STEEL	145	0	8	31	15	41	10	11	13	2	14	0
LESS THAN 100 TONS	135	0	7	29	15	39	10	11	12	1	11	0
101 TO 500	5	0	0	1	0	2	0	0	0	0	2	0
501 TO 1000	1	0	0	1	0	0	0	0	0	0	0	0
1001 TO 2500	2	0	0	0	0	0	0	0	0	1	1	0
2501 TO 5000	0	0	0	0	0	0	0	0	0	0	0	0
5001 TO 10000	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 10000	2	0	1	0	0	0	0	0	1	0	0	0
ALLOY STEEL	72	0	4	12	7	20	5	3	10	1	10	0
LESS THAN 100 TONS	55	0	2	11	6	17	3	2	7	0	7	0
101 TO 500	11	0	1	1	1	2	1	0	2	0	3	0
501 TO 1000	2	0	0	0	0	0	0	1	1	0	0	0
1001 TO 2500	0	0	0	0	0	0	0	0	0	0	0	0
2501 TO 5000	1	0	0	0	0	0	1	0	0	0	0	0
5001 TO 10000	1	0	0	0	0	1	0	0	0	0	0	0
MORE THAN 10000	2	0	1	0	0	0	0	0	0	1	0	0
ALL HEAVY MELTING STEEL	151	0	8	31	19	40	10	13	15	1	14	0
LESS THAN 100 TONS	37	0	5	10	6	8	1	3	2	0	2	0
101 TO 500	61	0	1	14	8	19	4	6	6	0	3	0
501 TO 1000	17	0	0	2	2	5	2	1	5	0	0	0
1001 TO 2500	24	0	1	5	3	6	2	0	1	0	6	0
2501 TO 5000	3	0	0	0	0	0	0	2	0	0	1	0
5001 TO 10000	5	0	0	0	0	2	1	1	0	0	1	0
MORE THAN 10000	4	0	1	0	0	0	0	0	1	1	1	0
NO. 1 ELEC FURNACE BUNDLES	59	0	3	13	7	14	7	2	6	0	7	0
LESS THAN 100 TONS	17	0	2	3	3	3	2	1	1	0	2	0
101 TO 500	21	0	1	8	3	4	1	0	3	0	1	0
501 TO 1000	11	0	0	1	1	5	1	0	2	0	1	0
1001 TO 2500	7	0	0	1	0	2	1	1	0	0	2	0
2501 TO 5000	2	0	0	0	0	0	2	0	0	0	0	0
5001 TO 10000	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 10000	1	0	0	0	0	0	0	0	0	0	1	0
NO. 2 ALL OTHER BUNDLES	103	0	4	23	16	26	8	6	10	1	9	0
LESS THAN 100 TONS	34	0	1	10	8	7	1	2	1	1	3	0
101 TO 500	35	0	2	7	5	10	3	3	4	0	1	0
501 TO 1000	13	0	0	1	2	3	2	1	3	0	1	0
1001 TO 2500	16	0	1	4	1	5	1	0	2	0	2	0
2501 TO 5000	3	0	0	1	0	1	1	0	0	0	0	0
5001 TO 10000	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 10000	2	0	0	0	0	0	0	0	0	0	2	0

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	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-THAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
NONFERROUS	160	0	9	31	21	41	10	14	17	2	15	0
LESS THAN 100 TONS	119	0	6	27	16	33	7	12	9	1	8	0
101 TC 500	27	0	2	2	4	7	2	1	5	0	4	0
501 TC 1000	6	0	0	2	1	1	0	0	0	0	2	0
1001 TO 2500	1	0	0	0	0	0	1	0	0	0	0	0
2501 TO 5000	1	0	0	0	0	0	0	1	0	0	0	0
5001 TO 10000	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 10000	6	0	1	0	0	0	0	0	3	1	1	0
OTHER CATEGORIES	36	0	2	7	3	11	4	3	2	1	3	0
LESS THAN 100 TONS	16	0	0	4	2	4	1	0	1	1	3	0
101 TC 500	13	0	2	2	1	4	1	2	1	0	0	0
501 TC 1000	2	0	0	1	0	1	0	0	0	0	0	0
1001 TO 2500	0	0	0	0	0	0	0	0	0	0	0	0
2501 TO 5000	4	0	0	0	0	2	1	1	0	0	0	0
5001 TO 10000	1	0	0	0	0	0	1	0	0	0	0	0
MORE THAN 10000	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL SCRAP SHIP PER MONTH	197	1	12	42	23	50	14	14	18	2	21	0
LESS THAN 500	65	1	5	16	12	16	3	3	2	1	6	0
501 TO 1000	40	0	4	11	4	9	3	4	3	0	2	0
1001 TO 2500	37	0	1	6	2	12	3	2	6	0	5	0
2501 TO 5000	27	0	0	7	4	7	1	3	1	0	4	0
5001 TO 10000	11	0	1	1	0	3	3	1	1	0	1	0
MORE THAN 10000	15	0	1	0	0	3	1	1	5	1	3	0
PROCESD SCRAP SHIP BY RAIL	201	1	12	39	26	56	15	16	17	2	17	0
USES RAIL TODAY	193	1	9	38	26	54	15	15	17	2	16	0
LESS THAN 26 PERCENT	42	1	5	14	4	8	2	0	4	0	4	0
26 TO 50 PERCENT	19	0	0	5	1	8	3	0	1	0	1	0
51 TO 75 PERCENT	20	0	1	3	2	10	1	2	1	0	0	0
MORE THAN 75 PERCENT	112	0	3	16	19	28	9	13	11	2	11	0
USED RAIL 5 YEARS AGO	190	1	11	36	23	52	15	16	17	2	17	0
LESS THAN 26 PERCENT	24	0	2	11	0	5	2	0	3	0	1	0
26 TO 50 PERCENT	25	1	3	4	2	5	2	2	3	0	3	0
51 TO 75 PERCENT	25	0	1	6	2	9	2	3	1	0	1	0
MORE THAN 75 PERCENT	116	0	5	15	19	33	9	11	10	2	12	0
PROCESD SCRAP SHIP BY TRUCK	198	1	18	48	21	58	13	8	15	1	15	0
USES TRUCK TODAY	198	1	18	48	21	58	13	8	15	1	15	0
LESS THAN 26 PERCENT	86	0	3	13	12	29	7	6	8	1	7	0
26 TO 50 PERCENT	24	0	1	5	2	8	2	1	3	0	2	0
51 TO 75 PERCENT	15	1	1	6	0	4	0	0	2	0	1	0
MORE THAN 75 PERCENT	73	0	13	24	7	17	4	1	2	0	5	0
USED TRUCK 5 YEARS AGO	183	1	17	45	17	54	12	8	14	1	14	0
LESS THAN 26 PERCENT	90	0	5	13	12	30	7	7	8	1	7	0
26 TO 50 PERCENT	26	0	3	5	1	10	1	1	2	0	3	0
51 TO 75 PERCENT	14	1	0	5	0	3	0	0	3	0	2	0
MORE THAN 75 PERCENT	53	0	9	22	4	11	4	0	1	0	2	0
USED BARGE 5 YEARS AGO	3	0	0	0	0	0	3	0	0	0	0	0
PROCESD SCRAP SHIP BY BARGE	10	1	0	1	0	0	4	3	1	0	0	0
USES BARGE TODAY	7	1	0	1	0	0	3	1	1	0	0	0
LESS THAN 26 PERCENT	5	1	0	1	0	0	2	1	0	0	0	0
26 TO 50 PERCENT	1	0	0	0	0	0	1	0	0	0	0	0

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	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	1	0	0	0	0	0	0	0	1	0	0	0
LESS THAN 26 PERCENT	2	0	0	1	0	0	1	0	0	0	0	0
26 TO 50 PERCENT	1	0	0	0	0	0	0	1	0	0	0	0
51 TO 75 PERCENT	2	0	0	0	0	0	1	0	1	0	0	0
MORE THAN 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
PROCESD SCRAP SHIP OTHER MODE	3	0	0	2	0	0	0	0	0	0	1	0
USES OTHER MODE TODAY	3	0	0	2	0	0	0	0	0	0	1	0
LESS THAN 26 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
26 TO 50 PERCENT	1	0	0	0	0	0	0	0	0	0	1	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	2	0	0	2	0	0	0	0	0	0	0	0
USED OTHER MODE 5 YEARS AGO	3	0	0	2	0	0	0	0	0	0	1	0
LESS THAN 26 PERCENT	1	0	0	0	0	0	0	0	0	0	1	0
26 TO 50 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
51 TO 75 PERCENT	0	0	0	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	2	0	0	2	0	0	0	0	0	0	0	0
SCRAP SHIPPED TO STEEL MILLS	171	1	4	31	26	53	12	12	15	2	15	0
1 TO 25 PERCENT	31	1	1	5	6	11	2	0	2	0	3	0
26 TO 50 PERCENT	26	0	0	6	2	9	4	2	1	1	1	0
51 TO 75 PERCENT	36	0	1	10	5	13	0	2	3	0	2	0
MORE THAN 75 PERCENT	78	0	2	10	13	20	6	8	9	1	9	0
SCRAP SHIPPED TO FOUNDRIES	181	1	7	38	25	54	14	11	13	2	16	0
1 TO 25 PERCENT	124	1	6	27	19	31	5	8	11	1	15	0
26 TO 50 PERCENT	29	0	0	9	1	10	5	2	0	1	1	0
51 TO 75 PERCENT	14	0	0	1	3	8	1	0	1	0	0	0
MORE THAN 75 PERCENT	14	0	1	1	2	5	3	1	1	0	0	0
SCRAP SHIP PROCESRS OR BROKRS	121	1	12	33	13	34	5	5	8	0	10	0
1 TO 25 PERCENT	63	0	6	9	5	27	3	4	5	0	4	0
26 TO 50 PERCENT	14	0	0	6	4	4	0	0	0	0	0	0
51 TO 75 PERCENT	7	0	0	2	0	1	0	0	1	0	3	0
MORE THAN 75 PERCENT	37	1	6	16	4	2	2	1	2	0	3	0
SCRAP SHIPPED ANY OTHER	27	0	4	6	2	7	4	1	1	0	2	0
1 TO 25 PERCENT	10	0	1	2	1	3	2	0	0	0	1	0
26 TO 50 PERCENT	1	0	0	0	0	0	1	0	0	0	0	0
51 TO 75 PERCENT	2	0	2	0	0	0	0	0	0	0	0	0
MORE THAN 75 PERCENT	14	0	1	4	1	4	1	1	1	0	1	0
PERCENT RANK LABOR COST	244	1	18	56	31	62	18	16	19	2	21	0
ONE	107	0	8	27	16	25	8	8	7	1	7	0
TWO	114	1	9	23	14	30	9	7	9	1	11	0
THREE	20	0	1	5	1	5	1	1	3	0	3	0
FOUR	3	0	0	1	0	2	0	0	0	0	0	0
PERCENT RANK RAW MATRL COST	244	1	18	56	31	62	18	16	19	2	21	0
ONE	130	1	10	27	13	37	10	6	12	1	13	0
TWO	65	0	3	18	7	16	6	6	5	1	3	0
THREE	36	0	3	10	9	6	2	2	1	0	3	0
FOUR	13	0	2	1	2	3	0	2	1	0	2	0
PERCENT RANK TRANSPORT COST	243	1	17	56	31	62	18	16	19	2	21	0
ONE	2	0	0	0	0	1	0	1	0	0	0	0
TWO	46	0	4	12	8	13	0	2	3	0	4	0

ABSOLUTE TALLY CLASSIFIED BY BASIC ANSWERS TO QUESTIONS IN TERMS OF REGION FOR ALL COMPANIES CALLED

	TOTAL	UN-KNOWN	NEW ENG-LAND	MID-DLE ATLAN TIC	SOUTH ATLAN TIC	EAST NORTH CEN-TRAL	EAST SOUTH CEN-TRAL	WEST NORTH CEN-TRAL	WEST SOUTH CEN-TRAL	MOUN-TAIN	PAC-IFIC	OUTSID UNI-TED STATE
THREE	150	1	10	34	14	41	13	9	15	1	12	0
FOUR	45	0	3	10	9	7	5	4	1	1	5	0
PERCENT RANK FINANCIAL COST	243	1	17	56	31	62	18	16	19	2	21	0
ONE	7	0	0	2	2	1	0	1	0	0	1	0
TWO	18	0	2	3	2	2	3	1	2	0	3	0
THREE	36	0	3	7	7	9	2	4	0	1	3	0
FOUR	182	1	12	44	20	50	13	10	17	1	14	0
TOTAL REVENUE FOR 1969	215	1	14	47	28	55	17	13	18	2	20	0
LESS THAN $500.000	77	0	5	22	12	16	7	5	5	2	3	0
$500,000 TO $1 MILLION	39	0	4	6	7	11	2	1	6	0	2	0
$1 TO $3 MILLION	60	0	3	11	7	19	4	5	3	0	8	0
$3 TO $5 MILLION	20	0	0	5	2	5	2	1	3	0	2	0
$5 TO $7 MILLION	8	0	1	1	0	1	1	1	1	0	2	0
$7 TO $10 MILLION	3	0	0	1	0	2	0	0	0	0	0	0
$10 TO $15 MILLION	5	1	1	0	0	1	1	0	0	0	1	0
OVER $15 MILLION	3	0	0	1	0	0	0	0	0	0	2	0
NUMBER OF EMPLOYEES	244	1	18	55	31	63	18	16	19	2	21	0
1 TO 10	80	0	9	22	12	17	6	3	5	1	5	0
11 TO 25	80	0	6	18	12	20	4	8	5	1	6	0
26 TO 50	53	0	2	13	4	18	4	3	6	0	3	0
MORE THAN 50	31	1	1	2	3	8	4	2	3	0	7	0
NUMBER OF FOREMEN	222	1	17	48	28	59	16	15	18	0	20	0
1 TO 3	116	0	10	30	15	30	7	8	7	0	9	0
4 TO 6	64	0	5	14	10	18	5	4	4	0	4	0
7 TO 10	27	0	1	3	2	9	1	3	7	0	1	0
MORE THAN 10	15	1	1	1	1	2	3	0	0	0	6	0
HOURS OPERATE PER WEEK	246	1	18	57	31	64	18	15	19	2	21	0
LESS THAN 41	88	1	8	19	14	18	9	4	3	1	11	0
41 TO 48	106	0	4	27	13	36	6	7	12	1	6	0
49 TO 80	46	0	6	11	4	13	1	4	4	0	3	0
MORE THAN 80	6	0	0	0	0	3	2	0	0	0	1	0
TOTAL CAPTL INVSTM PLNT EQPMT	221	1	15	50	29	56	17	14	18	2	19	0
LESS THAN $250.000	73	0	9	19	15	13	7	4	6	0	0	0
$250.000 TO $500.000	56	0	2	11	8	14	3	5	4	2	7	0
$500.000 TO $1 MILLION	55	0	4	12	4	15	5	2	5	0	8	0
$1 TO $2 MILLION	24	1	0	5	2	8	0	2	3	0	3	0
$2 TO $7 MILLION	10	0	0	2	0	5	2	1	0	0	0	0
$7 TO $10 MILLION	2	0	0	0	0	1	0	0	0	0	1	0
OVER $10 MILLION	0	0	0	0	0	0	0	0	0	0	0	0
ISIS MEMBER OR NONMEMBER	244	1	18	57	31	62	18	16	18	2	21	0
MEMBER-SAMPLE	170	1	8	42	21	45	11	11	12	1	18	0
MEMBER-ALTERNATE	43	0	4	9	5	11	4	3	4	0	3	0
NONMEMBER-SAMPLE	10	0	2	3	1	2	1	0	1	0	0	0
NONMEMBER-ALTERNATE	21	0	4	3	4	4	2	2	1	1	0	0

	Total	Unknown	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Moun-tain	Pac-ific	Outside U.S.
Type nonmarketable solid waste	247	1	18	57	31	64	18	16	19	2	21	0
No response	66	0	5	18	7	18	5	1	8	0	4	0
Rubber	37	0	1	12	2	10	0	4	5	1	2	0
Glass	3	0	0	1	0	2	0	0	0	0	0	0
Wood	24	0	3	10	3	4	0	1	1	0	2	0
Insulated wire	2	0	1	0	0	0	0	0	1	0	0	0
Garbage and/or trash, dirt	103	1	6	13	19	29	9	9	3	1	13	0
Plastics	1	0	1	0	0	0	0	0	0	0	0	0
Paper	10	0	2	2	0	1	3	1	1	0	0	0
Auto fabric and seats	1	0	0	0	0	0	1	0	0	0	0	0
Method of disposal	246	1	18	56	31	64	18	16	19	2	21	0
No response	71	0	5	20	7	19	6	1	8	0	5	0
Haul dump, other public disposal	149	1	13	31	20	35	9	14	11	2	13	0
Contracted out	6	0	0	1	0	2	2	0	0	0	1	0
Burn or incinerate	11	0	0	1	2	7	1	0	0	0	0	0
Sell	4	0	0	3	0	0	0	0	0	0	1	0
Dispose of on own property	5	0	0	0	2	1	0	1	0	0	1	0
Volume of business or operating level	247	1	18	57	31	64	18	16	19	2	21	0
No response	0	0	0	0	0	0	0	0	0	0	0	0
Availability of raw material	100	0	9	25	12	22	9	3	10	0	10	0
Dollar difference - raw material cost + scrap	107	1	7	23	16	28	5	11	8	1	7	0
Capacity processing facility	25	0	2	6	3	6	3	1	1	1	2	0
Other factors	15	0	0	3	0	8	1	1	0	0	2	0
Biggest problem as businessman	246	1	18	57	31	64	17	16	19	2	21	0
No response	13	0	1	3	0	3	2	2	2	0	0	0
Availability of labor	57	0	4	16	12	15	3	2	4	1	0	0
Market and steel technology	39	0	3	10	3	11	3	3	1	0	5	0
Legal, zoning, and government	14	0	1	4	3	1	0	1	3	0	1	0
Labor and other costs	56	0	3	11	3	15	6	4	8	1	5	0
Pollution, ecology, etc.	15	0	0	5	1	4	1	2	0	0	2	0
Transportation	7	0	0	1	1	3	0	0	1	0	1	0
Profits and prices	18	1	4	1	2	4	0	1	0	0	5	0
Operating, competition, modernization	17	0	2	4	3	5	2	0	0	0	1	0
Public relations/image	1	0	0	0	0	1	0	0	0	0	0	0
Equipment cost/maintenance	5	0	0	1	2	1	0	1	0	0	0	0
U.S. economy/recession	4	0	0	1	1	1	0	0	0	0	1	0
Biggest problem in scrap industry	244	1	18	57	31	63	16	16	19	2	21	0
No response	32	1	4	8	2	7	2	4	3	0	1	0
Availability of labor	21	0	2	6	3	4	0	2	2	1	1	0
Market and steel technology	54	0	3	13	6	20	3	3	3	0	3	0
Legal, zoning, and government	8	0	0	2	1	2	1	1	0	0	1	0
Labor and other costs	31	0	3	7	3	7	6	0	3	0	2	0
Pollution, ecology, etc.	28	0	1	6	9	7	2	1	0	1	1	0
Transportation	14	0	0	4	0	5	0	1	2	0	2	0
Profits and prices	21	0	2	2	3	4	1	2	3	0	4	0
Operating, competition, modernization	17	0	0	3	2	4	1	2	2	0	3	0
Public relations/image	5	0	0	2	1	1	0	0	0	0	1	0
Equipment cost/maintenance	4	0	2	1	0	0	0	0	1	0	0	0
U.S. economy/recession	9	0	1	3	1	2	0	0	0	0	2	0

Source: Extensive Survey.

APPENDIX B

TABLE B-1. SPECIFICATIONS FOR IRON AND STEEL SCRAP

A. Iron and Steel Scrap
as revised 1968
ISIS

GENERAL

a. Cleanness. All grades shall be free of dirt, non-ferrous metals, or foreign material of any kind, and excessive rust and corrosion. However, the terms "free of dirt, non-ferrous metals, or foreign material of any kind" are not intended to preclude the accidental inclusion of negligible amounts where it can be shown that this amount is unavoidable in the customary preparation and handling of the particular grade involved.

b. Off-grade material. The inclusion in a shipment of a particular grade of iron and steel scrap of a negligible amount of metallic material which exceeds to a minor extent the applicable size limitations, or which fails to a minor extent to meet the applicable requirements as to quality or kind of material, shall not change the classification of the shipment, provided it can be shown that the inclusion of such off-grade material is unavoidable in the customary preparation and handling of the grade involved.

c. Residual alloys. Wherever the term "free of alloys" is used in the classifications given herein, it shall mean that any alloys contained in the steel are residual and have not been added for the purpose of making an alloy steel. Steel scrap shall be considered free of alloys when the residual alloying elements do not exceed the following percentages:

	Per Cent
Nickel	0.45
Chromium	.20
Molybdenum	.10
Manganese	1.65

The combined residuals other than manganese shall not exceed a total of 0.60 percent.

d. Deviations. Any deviations from the general classifications of iron and steel scrap may be consummated by mutual agreement between buyer and seller.

BASIC OPEN HEARTH, BASIC OXYGEN, ELECTRIC FURNACE, AND BLAST FURNACE GRADES

No. 1 heavy melting steel. Wrought iron and/or steel scrap ¼ inch and over in thickness. Individual pieces not over 60 x 24 inches (charging box size) prepared in a manner to insure compact charging.

*No. 2 heavy melting steel.** Wrought iron and steel scrap, black and galvanized, ⅛ inch and over in thickness, charging box size to include material not suitable as No. 1 heavy melting steel. Prepared in a manner to insure compact charging.

*No. 2 heavy melting steel.** Wrought iron and steel scrap, black and galvanized, maximum size 36 x 18 inches. *May include all automobile scrap properly prepared.*

*The identical designations given for these two classifications are in accordance with established industry practices in specifying the materials desired.

No. 1 busheling. Clean steel scrap, not exceeding 12 inches in any dimensions, including new factory busheling (for example, sheet clippings, stampings, etc.). May not include old auto body and fender stock. Free of metal coated, limed, vitreous enameled, and electrical sheet containing over 0.5 percent silicon.

No. 1 bundles. New black steel sheet scrap, clippings or skeleton scrap, compressed or hand bundled, to charging box size, and weighing not less than 75 pounds per cubic foot. (Hand bundles are tightly secured for handling with a magnet.) May include Stanley balls or mandrel wound bundles or skeleton reels, tightly secured. May include chemically detinned material. May not include old auto body or fender stock. Free of metal coated, limed, vitreous enameled, and electrical sheet containing over 0.5 percent silicon.

No. 2 bundles. Old black and galvanized steel sheet scrap, hydraulically compressed to charging box size and weighing not less than 75 pounds per cubic foot. May not include tin or lead-coated material or vitreous enameled material.

No. 3 bundles. Old sheet steel, compressed to charging box size and weighing not less than 75 pounds per cubic foot. May include all coated ferrous scrap not suitable for inclusion in No. 2 bundles.

Incinerator bundles. Tin can scrap, compressed to charging box size and weighing not less than 75 pounds per cubic foot. Processed through a recognized garbage incinerator.

Bundled No. 1 steel. Wrought iron and/or steel scrap ⅛ inch or over in thickness, compressed to charging box size and weighing not less than 75 pounds per cubic foot. Free of all metal coated material.

Bundled No. 2 steel. Wrought iron or steel scrap, black or galvanized, ⅛ inch and over in thickness, compressed to charging box size and weighing not less than 75 pounds per cubic foot. Auto body and fender stock, burnt or hand stripped, may constitute a maximum of 60 percent by weight. (This percent based on makeup of auto body, chassis, driveshafts, and bumpers.) Free of all coated material, except as found on automobiles.

Machine shop turnings. Clean steel or wrought iron turnings, free of iron borings, non-ferrous metals in a free state, scale, or excessive oil. May not include badly rusted or corroded stock.

Machine shop turnings and iron borings. Same as machine shop turnings but including iron borings.

Shoveling turnings. Clean short steel or wrought iron turnings, drillings, or screw cuttings. May include any such material whether resulting from crushing, raking, or other processes. Free of springy, bushy, tangled or matted material, lumps, iron borings, non-ferrous metals in a free state, scale, grindings, or excessive oil.

Shoveling turnings and iron borings. Same as shoveling turnings, but including iron borings.

Iron borings. Clean cast iron or malleable iron borings and drillings, free of steel turnings, scale, lumps, and excessive oil.

Briquetted iron borings. Analysis and density to consumer's specifications.

Briquetted steel turnings. Analysis and density to consumer's specifications.

ELECTRIC FURNACE CASTING, AND FOUNDRY GRADES

Billet, bloom and forge crops. Billet, bloom, axle, slab, heavy plate and heavy forge crops, containing not over 0.05 percent phosphorus or sulphur and not over 0.5 percent silicon, free from alloys. Dimensions not less than 2 inches in thickness, not over 18 inches in width, and not over 36 inches in length.

Bar crops and plate scrap. Bar crops, plate scrap, forgings, bits, jars, and tool joints, containing not over 0.05 percent phosphorus or sulphur, not over 0.5 percent silicon, free from alloys. Dimensions not less than ½ inch in thickness, not over 18 inches in width, and not over 36 inches in length.

Cast steel. Steel castings not over 48 inches long or 18 inches wide, and ¼ inch and over in thickness, containing not over 0.05 percent phosphorus or sulphur, free from alloys and attachments. May include heads, gates, and risers.

Punchings and plate scrap. Punchings or stampings, plate scrap, and bar crops containing not over 0.05 percent phosphorus or sulphur and not over 0.05 percent silicon, free from alloys. All material cut 12 inches and under, and with the exception of punchings or stampings, at least ⅛ inch in thickness. Punchings or stampings under 6 inches in diameter may be any gauge.

Electric furnace bundles. New black steel sheet scrap hydraulically compressed into bundles of size and weight as specified by consumer.

Cut structural and plate scrap, 3 feet and under. Clean open hearth steel plates, structural shapes, crop ends, shearings, or broken steel tires. Dimensions not less than ¼ inch in thickness, not over 3 feet in length and 18 inches in width. Phosphorus or sulphur not over 0.05 percent.

Cut structural and plate scrap, 2 feet and under. Same as cut structural and plate scrap 3 feet and under, except for length.

Cut structural and plate scrap, 1 foot and under. Same as cut structural and plate scrap, 3 feet and under, except for length.

Foundry steel, 2 feet and under. Steel scrap ⅛ inch and over in thickness, not over 2 feet in length or 18 inches in width. Individual pieces free from attachments. May not include nonferrous metals, cast or malleable iron, cable, vitreous enameled, or metal coated material.

Foundry steel, 1 foot and under. Same specifications as 2-foot material, except for length.

Springs and crankshafts. Clean automotive springs and crankshafts, either new or used.

Alloy free turnings. Clean shoveling steel turnings free from lumps, tangled or matted material, iron borings, or excessive oil containing not more than 0.05 percent phosphorus or sulphur, and free of alloys.

Hard steel cut 30 inches and under. Automotive steel consisting of rear ends, crankshafts, driveshafts, front axles, springs, and gears prepared 30 inches and under. May not include miscellaneous small shoveling steel or any pieces too bulky for gray iron foundry use.

SPECIALLY PROCESSED GRADES TO MEET CONSUMER REQUIREMENTS

Grades of scrap prepared especially to meet with steel mill or foundry requirements, individual specifications to be agreed on between consumer and supplier.

CAST IRON GRADES

Cupola cast. Clean cast iron scrap such as columns, pipes, plates, and castings of a miscellaneous nature, including automobile blocks and cast iron parts of agriculture and other machinery. Free from stove plate, burnt iron, brake shoes or foreign material. Cupola size, not over 24 inches x 30 inches, and no piece over 150 pounds in weight.

Charging box cast. Clean cast iron scrap in sizes not over 60 inches in length or 30 inches in width, suitable for charging into an open hearth furnace without further preparation. Free from burnt iron, brake shoes or stove plate.

Heavy breakable cast. Cast iron scrap over charging box size or weighing more than 500 pounds. May include cylinders and driving wheel centers. May include steel which does not exceed 10 percent of the casting by weight.

Hammer blocks or bases. Cast iron hammer blocks or bases.

Burnt iron. Burnt cast iron scrap, such as stove parts, grate bars, and miscellaneous burnt iron. May include sash weights or window weights.

Mixed cast. May include all grades of cast iron except burnt iron. Dimensions not over 24 inches x 30 inches and no piece over 150 pounds in weight.

Stove plate, clean cast iron stove. Free from malleable and steel parts, window weights, plow points, or burnt cast iron.

Clean auto cast. Clean auto blocks; free of all steel parts except camshafts, valves, valve springs, and studs. Free of non-ferrous and non-metallic parts.

Unstripped motor blocks. Automobile or truck motors from which steel and non-ferrous fittings may or may not have been removed. Free from driveshafts and all parts of frames.

Drop broken machinery cast. Clean heavy cast iron machinery scrap that has been broken under a drop. All pieces must be of cupola size, not over 24 inches x 30 inches, and no piece over 150 pounds in weight.

Malleable. Malleable parts of automobiles, railroad cars, locomotives, or miscellaneous malleable iron castings. Free from cast iron and steel parts and other foreign material.

SPECIAL GRADES

No. 1 chemical borings. New clean cast or malleable iron borings and drillings containing not more than 1 percent oil, free from steel turnings, or chips, lumps, scale, corroded or rusty material.

No. 2 chemical borings. New clean cast or malleable iron borings and drillings, containing not more than 1.50 percent oil, free from steel turnings, or chips, lumps, scale, corroded or rusty material.

SPECIFICATIONS FOR SHREDDED STEEL SCRAP

as developed by the Marketing and Specifications Committee, and approved by the Board of Directors, of the Institute of Scrap Iron & Steel, Inc.-April,1971

1. Shredded Scrap: Homogeneous iron and steel scrap, magnetically separated, originating from automobiles, unprepared No. 1 and No. 2 steel, miscellaneous baling and sheet scrap. Average density 50 pounds, per cubic foot.

2. Shredded Scrap: Homogeneous iron and steel scrap, magnetically separated, originating from automobiles, unprepared No. 1 and No. 2 steel, miscellaneous baling and sheet scrap. Average density 70 pounds, per cubic foot.

3. Shredded Clippings: Shredded 1000 series carbon steel clippings or sheets. Material should have an average density of 60 pounds, per cubic foot.

B. Alloy Scrap
as issued 1961
ISIS

AROMA

(70) *New Nickel* shall consist of new clippings, plate, skeleton, and all other rolled shapes.

Nickel plus cobalt minimum	99 per cent
Cobalt maximum	.25 per cent
Copper maximum	.50 per cent

This grade shall be free of all castings.

BURLY

(71) *Old Nickel.* All rolled nickel scrap shall come under this classification. Shall consist of clean scrap and shall be free of soldered, brazed, sweated, welded, or painted material.

Nickel minimum	98 per cent
Copper maximum	.50 per cent

CACHE

(72) *Miscellaneous Nickel* shall consist of miscellaneous nickel scrap, such as carbonized scrap, castings, strippings, peelings, baskets and/or turnings, and shall be packed and sold separately on basis of analysis.

COMPLEX

(73) *S-816, Etc.* shall consist of alloys in which the principal constituents are nickel, cobalt, chromium, and other alloying elements. It shall be sold on the basis of description and analysis. (This category refers to such alloys as Hastelloys, Stellites, S-816, etc.)

DAFFY

(74) *Ni-Resist Solids* shall consist of clean Ni-Resist solids and shall be sold according to type or analysis (Type I—approximately 6 per cent copper, all others, such as Types II, III, IV, and V—free of copper); shipment shall be of uniform grade unless otherwise agreed on by buyer and seller and must be free of foreign attachments and all other contamination.

DAISY

(75) *Ni-Resist Borings* shall consist of clean and dry Ni-Resist borings and shall be sold according to type or analysis (Type I—approximately 6 per cent copper, all others, such as Types II, III, IV, and V—free of copper); shipment shall be of uniform grade unless otherwise agreed on by buyer and seller. Must be free of all contamination.

DEPTH

(80) *Miscellaneous Nickel-Copper and Nickel-Copper Iron* shall consist of miscellaneous scrap in which the basic elements, by weight, are nickel and copper, such as copper nickel peelings, plating racks, and hangers, and all nickel and copper in attached or combined form. In all cases, miscellaneous nickel copper scrap should be sold by description and analysis.

Hitch

(81) *New Monel Clippings and Solids* shall consist of new clean, regular and/or R-Monel clippings, plate, and other rolled shapes. Must be free of foreign attachments and all other contamination.

House

(82) *Monel Rods and Forgings* shall consist of regular and/or R-Monel rods and forgings. K and KR Monel rods and forgings must be packed and sold separately. Must be free of foreign attachments and all other contamination.

Ideal

(83) *Old Monel Sheet and Solids* shall consist of clean, regular and/or R-Monel solids, such as sheet, plate, pipe, rods, and forgings, and screen or wire cloth. Must be free of foreign attachments and all other contamination, soldered, brazed, welded, or sweated material.

Junto

(84) *Soldered Monel Sheet and Solids* shall consist of soldered and/or brazed regular and/or R-Monel sheet and solids. Must be free of trimmed seams and edges and all other contamination.

Kamis

(85) *Soldered Monel Wire, Screen, and Cloth* shall consist of soldered and/or brazed regular Monel wire, screen, and cloth. Must be free of trimmed seams and edges, non-metallic filling, and all other contamination.

Karat

(86) *New Monel Wire, Screen, and Cloth* shall consist of new, clean regular Monel wire, screen, and cloth, free of soldered material, as well as all other contamination.

Lemon

(87) *Monel Castings* must contain a minimum of 60 per cent nickel and shall consist of clean, regular, S or H Monel castings. Must be free of foreign attachments and all other contamination.

Lemur

(88) *Monel Turnings and Borings* must contain a minimum of 60 per cent nickel and shall consist of clean and dry regular and R-Monel turnings and borings. K, KR, S, H, or mixed Monel turnings and borings must be packed and sold separately. Must be free of all contamination.

Obole

(95) *Ferro-Nickel-Chrome Iron* shall consist of alloys containing:

Chrome minimum	12 per cent
Nickel minimum	12 per cent
Copper maximum	.50 per cent

Free of other foreign elements. Material shall be sold on basis of description and analysis. This category excludes all stainless steel grades which are covered elsewhere.

Peach

(96) *Ferro-Nickel Iron* shall consist of alloys containing only nickel and iron. Minimum nickel content shall be 20 per cent, maximum copper .50 per cent. Material shall be sold on basis of description and analysis.

Pekoe

(97) *Chrome-Nickel-Manganese* shall be of the following analysis:

Chrome	16-19 per cent
Nickel	3.5-6 per cent
Manganese	5.5-10 per cent

Material to be free of harmful contaminants and be prepared to consumer's specifications.

Sabot

(98) *18-8 Stainless Steel* shall consist of clean scrap containing:

Nickel minimum	7 per cent
Chromium minimum	16 per cent
Molybdenum maximum	.50 per cent
Copper maximum	.50 per cent
Phosphorus maximum	.045 per cent
Sulphur maximum	.03 per cent

Otherwise free of harmful contaminants. Material to be prepared to individual consumer's specifications.

Taffy

(99) *Stainless Steel Castings.* Submit analysis, size of pieces, and physical description.

Ultra

(100) *18-8 Stainless Steel Turnings.* Machine shop grade for direct mill delivery shall contain:

Nickel minimum	7 per cent
Chromium minimum	16 per cent

Must be free of all nonferrous metals, nonmetallics, excessive iron, oil, and harmful contaminants.

Ultra Crush

(101) *Short or Crushed Stainless Steel Turnings* shall conform chemically to machine shop grade specifications.

Rusten

(102) *11-14 Per Cent Straight Chrome Stainless* shall contain:

Chrome	11-14 per cent
Phosphorus maximum	.03 per cent
Sulphur maximum	.03 per cent
Nickel maximum	.50 per cent

Otherwise free of harmful contaminants. Material to be prepared to individual consumer's specifications.

Rusthirty

(103) *14-18 Per Cent Straight Chrome Stainless* shall contain:

Chrome	14-18 per cent
Phosphorus maximum	.03 per cent
Sulphur maximum	.03 per cent
Nickel maximum	.50 per cent

Otherwise free of harmful contaminants. Material to be prepared to individual consumer's specifications.

Vaunt

(104) *Edison Batteries* shall be sold by type and to be free of crates and liquid.

Nadir

(105) *High Nickel* shall consist of nickel-steel billet, bloom, bar crops, or other shapes of similar section and equal grade, not over .04 per cent phosphorus or sulphur, between 3 per cent and 3.5 per cent nickel (lower or higher in nickel content to be duly considered), free from other alloys. Must be clean material. Size of material to be agreed upon between buyer and seller.

Natty

(106) *No. 1 Chromium Nickel* shall consist of chromium-nickel steel billet, bloom, bar crops, or other shapes of similar section and equal grade, not over .04 per cent phosphorus or sulphur, between 3 and 3.5 per cent nickel (lower or higher nickel content to be duly considered), not over 0.5 per cent chromium, free from other alloys. Must be clean material. Size of material to be agreed upon between buyer and seller.

NEGUS

(107) *No. 2 Chromium-Nickel* shall consist of chromium-nickel steel billet, bloom, bar crops, or other shapes of similar section and equal grade, not over .04 per cent phosphorus or sulphur, between 1.5 and 2.5 per cent nickel (lower or higher nickel content to be duly considered), between .5 and 1 per cent chromium, free from other alloys. Must be clean material. Size of material to be agreed upon between buyer and seller.

NAVE

(108) *Nickel-Steel Turnings* shall consist of heavy short first-cut turnings from nickel-steel forgings. Nickel and chromium content to be specified on each individual sale. To weigh not less than 75 pounds per cubic foot. To be free from dirt and other foreign materials.

C. Railroad Scrap
as revised 1968
Association of American Railroads

(2) *Axles, Steel.* Solid car, 6 x 11 inch journal and over (free of axles with key-way between wheel seats, no axles of shorter lengths than distances between wheel seats to be included).

(2A) *Axles, Steel.* Solid Diesel locomotive: (no axles of shorter length than distance betwen wheel seats to be included).

(3) *Axles, Steel.* Solid car and/or locomotive 5½ x 10 inch journal and under, (no axles to be included of shorter lengths than distances between wheel seats).

(3A) *Axles, Steel.* Roller bearing (no axle of shorter length than distance between wheel seats to be included).

(4) Spikes, Track Bolts and Nuts, and Lock Washers, may include Rail Anchors.

(5) *Tie Plates.* Steel.

(6) *Rail Joints, Angle and/or Splice Bars.* Steel.

(9) *Bolsters and/or Truck Sides, Frames:* Uncut. Cast steel.

(11) *Cast Steel, No. 2.* Steel Castings, over 18 inches wide and/or over 5 feet long.

(11A) *Cast Steel, No. 1.* Steel Castings, 18 inches and under, not over 5 feet long, including cut truck side frames and bolsters.

(12) *Cast Iron, No. 1.* Cast iron scrap, such as columns, pipes, plates, and/or castings of miscellaneous nature, but free from stove plates, brake shoes and burnt scrap. Must be cupola size, not over 24 inches by 30 inches in dimensions and no piece to weigh over 150 pounds. Must be free from foreign material.

(13) *Cast Iron, No. 2.* Pieces weighing over 150 pounds, but not more than 500 pounds. Free from burnt cast.

(14) *Cast Iron, No. 3.* Pieces weighing over 500 pounds; includes cylinders, driving wheel centers and/or all other castings. (Free from hammer blocks or bases).

(15) *Cast Iron, No. 4.* Burnt cast iron scrap, such as grate bars, stove parts and/or miscellaneous burnt scrap.

(16) *Cast Iron Brake Shoes.* Brake Shoes of all types except composition filled shoes.

(17) *Couplers and/or Knuckles.* Railroad car and/or locomotive steel couplers, knuckles and/or locks stripped clean of all other attachments.

(18) *Frogs and/or Switches, uncut.* Steel frogs and switches that have not been cut apart, exclusive of manganese.

(18A) *Railbound Manganese Frogs and Switch Points with manganese inserts that have not been cut apart.*

(23) *Malleable.* Malleable parts of automobiles, railroad cars, locomotive and/or miscellaneous malleable castings.

(24) *Melting Steel, Railroad No. 1.* Clean wrot iron or steel scrap, ¼ inch and over in thickness, not over 18 inches in width, and not over 5 feet in length. May include pipe ends and material ⅛ inch to ¼ inch in thickness, not over 15 inches x 15 inches. Individual pieces cut so as to lie reasonably flat in charging box.

(27) *Rail, Steel No. 1.* Standard section tee rails, original weight 50 pounds per yard or heavier, 10 feet long and over. Suitable for rerolling into bars and shapes. Free from bent and twisted rails, frog, switch and guard rails, or rails with split heads and broken flanges. Continuous welded rail may be included provided no weld is over 9 inches from the end of the piece of rail.

(28A) Rail, Steel No. 2 Cropped Rail Ends Standard Section, original weight of 50 pounds per yard and over, 18 inches and under.

(28B) Rail, Steel No. 2 Cropped Rail Ends Standard Section, original weight of 50 pounds per yard and over, 2 feet long and under.

(28C) *Rail, Steel No. 2.* Cropped Rail ends—Standard section, original weight 50 pounds per yard and over, 3 feet long and under.

(29) *Rail, Steel No. 3.* Standard section tee, girder and/or guard rails, to be free from frog and switch rails not cut apart, and contain no manganese, cast, welds or attachments of any kind except angle bars. Free from concrete, dirt and foreign material of any kind.

(30) *Sheet Scrap, No. 1.* Under 3/16 inch thick, may include hoops, band iron and/or steel, scoops and/or shovels (free of wood). Must be free from burnt or metal coated material, cushion or other similar springs.

(31) *Sheet Scrap, No. 2.* Galvanized or tinned material and/or gas retorts, and/or any other iron or steel material not otherwise classified.

(32) *Steel, Tool.* (Specify kind in offering.)

(33) *Steel, Manganese.* All kinds of manganese, rail, guard rails, frogs and/or switch points, cut or uncut.

(34) *Steel, Spring.* Coil and/or elliptical, minimum thickness ¼ inch may be assembled or cut apart.

(34A) *Steel, Spring.* Coil only.

(35) *Structural, Wrot Iron and/or Steel Uncut.* All steel or steel mixed with iron from bridges, structures and/or equipment that has not been cut apart; may include uncut bolsters, brakebeams, steel trucks, underframes, channel bars, steel bridge plates, frog and/or crossing plates and/or other steel of similar character.

(36) *Tires.* All Locomotive, not cut to specified lengths.

(36A) *Tires.* All Locomotive, cut 3 foot lengths and under.

(38) *Turnings, No. 1.* Heavy turnings from wrot iron and/or steel railroad axles or heavy forgings and/or rail chips, to weigh not less than 75 pounds per cubic foot. Free from dirt or other foreign material of any kind. Alloy steel scrap may be excluded from these specifications by mutual agreement between buyer and seller.

(38A) *Turnings, Drillings and/or Borings, No. 2.* Cast, wrot, steel and/or malleable iron borings, turnings and/or drillings mixed with other metals.

(40) *Wheels, No. 1.* Cast iron car wheels.

(42) *Wheels, No. 3.* Solid cast steel, forged, pressed and/or rolled steel car and/or locomotive wheels, not over 42 inches diameter. (Specify kind in offering.)

(45) *Destroyed Steel Cars.* Bodies of steel cars cut apart sufficiently to load. (Specify kind.)

(45A) *Destroyed Steel Car Sides and Box Car Roofs.* Cut to a maximum length of .... and a maximum width of .... suitable for use in super presses and shears without additional preparation.

APPENDIX C

PRIORITY RATING SYSTEM FOR RECOMMENDATIONS

Throughout this study, numerous problems and obstacles to increased recycling of ferrous solid waste have been identified and analyzed as have the potential opportunity areas for increased recycling. The means for achieving increased recycling by capitalizing on the opportunities and overcoming the problems and obstacles are therefore the recommendations offered in the Summary chapter.

Each recommendation is obviously not of equal importance, just as each problem, obstacle, and opportunity, is not of the same magnitude. Some are interrelated, and provide synergistic opportunities. Unfortunately, some overlap is unavoidable, due to the complexity of the subject. But the objective of all is to find solutions to the problems which inhibit achievement of increased recycling.

Within each opportunity area identified for increased recycling of ferrous solid waste, a priority was established for the recommendations offered. Due to the rapid changes taking place in our present environment, the priorities established should be considered only as a framework for the development of action plans at this time.

The priorities established were based on three weighted qualitative criteria, which were then quantified to offer the priority rating:

(1) To what extent would the achievement of the recommendation's objective increase the recycling of ferrous solid waste?

(2) What is the feasibility of achieving that objective?

(3) What is the cost/benefit relationship of achieving that objective?

Each recommendation was scored as significant, moderate, or limited in its effect for each category. The increased recycling category was given a maximum weight of 10, feasibility a maximum weight of 6, and cost/benefit a maximum weight of 4. The total maximum achievable rating therefore was 20.

APPENDIX D

BIBLIOGRAPHY--CONTENTS

- Solid Waste and Recycling--General

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Car shredding plant is opened in Nashville	#Am Mtl Mkt 11/5/68[illegible]
Depressed mkt intensifying acute scrap auto prblms	#Am Mtl Mkt 11/12/68p23
Market for ferrous scrap shows no particular trend	#Am Mtl Mkt 11/12/68p27
Scrap to go into building blocks	#Am Mtl Mkt 11/15/68p15
First major price change in yr noted in scrap mkt	#Am Mtl Mkt 11/15/68p18
Nonferrous market continues to be stagnant	#Am Mtl Mkt 11/18/68p21
Scrap bins for rest of '68 expected to remain light	#Am Mtl Mkt 12/2/68p23
Ferrous scrap prices are going up	#Am Mtl Mkt 12/9/68p19
Scrap prices move upward	#Steel 12/9/68p124
Nickel-bearing scrap is tight so prices rise	#Am Mtl Mkt 12/13/68p17
Ferrous scrap market shows signs of improvement	#Am Mtl Mkt 12/16/68p24
Scrap market is softening	#Am Mtl Mkt 12/24/68p20
New process increases scrap use	#Am Mtl Mkt 12/26/68p15
Copper, brass scrap steady:mkt remains quiet	#Am Mtl Mkt 12/27/67p19
Copper scrap price weakens as unions resume talks	#Am Mtl Mkt 12/27/67p21
Iron & steel scrap exports boom, US consump dips	#Am Mtl Mkt 12/27/67p22
Magnetic process speeds junk car to scrap conversn	#Am Mtl Mkt 12/29/67p18
Brokers complain of lag in scrap intake	#Am Mtl Mkt 12/29/67p19

1969

Scrap Metals 50931 00

Management, Personnel & Procedures

Scrap processors seek mkt improvement methods	# Iron Age	1/23/69	57
Scrap mtl dealers urged to heed alloys progress	Am Mtl Mkt	4/15/69	1
Scrap executives battle over bigness trend	# Am Mtl Mkt	4/18/69	1
Scrap industry seen diversifying	Am Mtl Mkt	10/ 8/69	23

Product Forecasts & Market Data

Stronger scrap market is predicted for '69	# Am Mtl Mkt	12/31/68	24
Little change in scrap mkt seen until after Jan	# Am Mtl Mkt	12/31/68	24
Frisco scrap market is on a steady keel	# Am Mtl Mkt	1/ 2/69	22
Most scrap dealers optimistic about business in '69	# Am Mtl Mkt	1/ 8/69	22
Surveys scrap metal industry prospects	# Am Mtl Mkt	1/13/69	57
Mkt for scrap iron shows little strength	# Am Mtl Mkt	2/19/69	23
Scrap industry hurt by freight car shortage	Steel	4/ 7/69	21
NASMI meeting tinged with optimism	Am Mtl Mkt	4/15/69	1
Views reasons for firm alumn scrap mkt	Am Mtl Mkt	4/16/69	1
Titanium scrap boom expected in the 1970's	Am Mtl Mkt	4/16/69	1
New interest in elec furnaces to benefit scrap ind	Am Mtl Mkt	4/22/69	22
Scrap holding mkts despite sagging prices	# Am Mtl Mkt	4/28/69	2
Michigan parley on scrap ind. summary	# Am Mtl Mkt	4/30/69	23
Scrap supply pinch feared as export surge threatens	Steel	5/12/69	86
Scrap prices maintained by export demand	Steel	6/ 9/69	72
Brokers optimistic on scrap sales	Am Mtl Mkt	6/13/69	15
Secondary metal service growth seen	# Am Mtl Mkt	6/24/69	1
Scrap metal trading sluggish	Steel	7/ 7/69	104
Export scrap steel bsns reviving at Buffalo port	Am Mtl Mkt	7/ 8/69	23
Dealers report record ferrous scrap volume	# Jrl Comm	7/28/69	4
Steel scrap mkt reported 'topped out' in Chicago	Am Mtl Mkt	9/11/69	20
Scrap iron market in Pittsburgh easing	Am Mtl Mkt	9/25/69	24
Svys severe competition in scrap processing ind	# Metal News	10/13/69	30
Steel foundry scrap market stabilized	Am Mtl Mkt	10/24/69	16
Tight money policy hitting scrap market	Am Mtl Mkt	10/31/69	19
Scrap processing industry forecasts future mkts	# Steel	12/ 1/69	29
Scrap steel supplies seen tight in 1970	Jrl Comm	12/22/69	4

Costs & Pricing

Scrap prices hit bottom during '68	# Am Mtl Mkt	1/ 2/69	19
Open hearth grade prices expected to rise $2-$3	# Am Mtl Mkt	1/ 3/69	19
Cast scrap prices up $2 a ton	# Am Mtl Mkt	1/10/69	19
Scrap metal freight rates boosted 5% by ICC	# Am Mtl Mkt	1/24/69	1
Scrap steel prices decline with inflationary mkt	# NY Times	1/26/69	F14
Analysis of stainless scrap price trends	# Iron Age	2/20/69	56
Sales of cargos to Japan push scrap iron prices up	# Am Mtl Mkt	2/25/69	23
Scrap iron prices jump $5/ton over April	# Am Mtl Mkt	4/30/69	1
Export activity is major influence on scrap prices	Am Mtl Mkt	5/12/69	9
Scrap iron mkt prices continues upward trend	Am Mtl Mkt	5/21/69	5
Prices on steel scrap rise in Pittsburgh,Cleveland & Chicago	Wall St Jl	8/ 5/69	21
Exports provide major support to scrap prices	# Steel	8/25/69	60
Strong scrap iron prices reflect higher stl output	Am Mtl Mkt	8/28/69	1
Pittsburgh scrap iron prices level off	Am Mtl Mkt	9/10/69	2
High scrap prices may bring switch to pre-reduced pellets	Am Mtl Mkt	9/10/69	5
Steel scrap prices down $2 to $3	Am Mtl Mkt	9/29/69	2
High quotes cause steel scrap prices to tumble	# Wall St Jl	10/ 1/69	38
Industrial scrap prices decline	Am Mtl Mkt	10/30/69	3
Steel scrap prices jump $4/ton in Chicago	Wall St Jl	12/ 1/69	18
Scrap nickel price to be strong for months	Am Mtl Mkt	12/ 1/69	15
RR rates disturb scrap shippers	Rwy Age	12/15/65	34

New Products & Technology

Ferrous scrap industry modernizes	# Steel	1/13/69	47

Regulatory & Legal

ISA head urges stockpiling of scrap metals	# Am Mtl Mkt	3/18/69	23
Meissner hints retention of export scrap controls	# Am Mtl Mkt	6/ 4/69	1
Export ban on Ni & Ni-bearing scrap precautionary	Am Mtl Mkt	7/15/69	1
Relief for scrap shippers supported by Institute in Senate	# Am Mtl Mkt	8/ 8/69	16
Scrap Inst supports hike in truck size,weight limits	Am Mtl Mkt	8/14/69	16

Autos for Scrap 50932 00

New method of melting cars developed	# Am Mtl Mkt	2/17/6	23
Scrappage rate shows decline for cars & trucks	# Auto News	3/24/69	1
Low scrap prices cause auto disposal problems	# Wall St Jl	6/25/69	1
Greater use of scrap metal may ease auto refuse problem & lower new car costs	# Metal News	12/ 8/69	21

1970

50930 00 Scrap & Waste Materials Whole

Sporadic short-range buying upsets iron & steel scrap market	# Am Mtl Mkt	5/25/70	1A
Lukens chief asks cuts on growing scrap exports	# Metal News	8/24/70	18
Illinois starts inquiry on 42 scavenger firms in Chicago	Wall St Jl	9/16/70	4
Computer punched cards in demand by salvage cos	# Computrwld	10/ 7/70	1
Industry moves into recycling business, analyzes profit potential	# Bus Week	10/10/70	66
Paper & steel cos study recycling as antipollution measure	# Ad Age	10/19/70	63
RRC campaign to recycle discarded computer printouts	# Computrwld	10/21/70	7

Scrap Metals 50931 00

Institutional Structure

Small cos can function in the scrap industry	Am Mtl Mkt	11/25/70	16
Surveys scrap industry in the 1970's	# Iron Age	12/24/70	23

Management Procedures

Bureau of Mines R&D puts stress on metals recycling, efficient scrap use	# Iron Age	8/13/70	89

1970 continued

Technology

Scrap dealers urge research to recycle solid waste	Am Mtl Mkt	3/ 4/70	1
Ferrous waste objectives defined	Am Mtl Mkt	7/29/70	14
GM develops process for reclaiming scrap at stamping plants	Wall St Jl	3/ 2/70	2
New GM process turns scrap into reconstituted stl	Bus Week	3/ 7/70	24
Scrap industry studies GM scrap sheet handling	Am Mtl Mkt	3/ 9/70	6
Steel makers study scrap conversion method	Metal News	3/ 9/70	6
System unveiled to recycle scrap metal cans	Am Mtl Mkt	3/16/70	1
Tests show scrap tin-free cans make good steel	Am Mtl Mkt	6/ 9/70	4

Physical & Capital Resources

Scrap processors pour big money into equipment	# Iron Age	6/11/70	88
Scrap iron, steel consumptn records high in '69	# Am Mtl Mkt	1/29/70	15
Potential seen for secondary tungsten	# Am Mtl Mkt	3/16/70	S26
30 ships up for scrap sale	Am Mtl Mkt	9/11/70	2
11 more ships up for scrap bids	# Am Mtl Mkt	9/29/70	2
R Tessin's speech on metals recycling	Am Mtl Mkt	11/13/70	22
Maritime Administration offers 16 more ships for scrap	Am Mtl Mkt	11/30/70	2

Market Data

Scrap metals exec demands more metals recycling	# Am Mtl Mkt	1/14/70	16
Scrap metals man says industry has no problems, only opportunities	Am Mtl Mkt	1/19/70	58
Scrap steel ind faces many problems in '70s	# Iron Age	1/29/70	46
World market battles for US scrap metal	Iron Age	3/ 5/70	47
GM 'recon' process would put premium on scrap	Ind Week	3/ 9/70	13
Scrap dealers may face competition from govt	Iron Age	3/12/70	19
Importance, growth of scrap metals process ind discussed	# Am Mtl Mkt	3/16/70	57
Raw materials shortages pinch ferrous mtls ind	Ind Week	3/16/70	22
Cooperation called key to scrap can problems	Am Mtl Mkt	4/24/70	6
Dept of Commerce studies scrap iron & stl shortage	Foundry	11/ /70	20

**Orders & Contracts*

Bullish outlook forecast for '70s scrap market	Am Mtl Mkt	1/20/70	1
Scrap industry decline predicted for 1970	# Metal News	1/26/70	18
Steel exec sees good '70s scrap market	# Ind Week	2/ 2/70	13
Long-term contracts in scrap marts seen as new trend	Am Mtl Mkt	11/23/70	20

**Production Information*

Scrap pre-heating ups steel production	Am Mtl Mkt	3/19/70	8

**Foreign Trade*

Commerce Dept asks for weekly reports on steel scrap & coal exports	Am Mtl Mkt	11/13/70	2

**Sales & Consumption*

Scrap copper receipts set record in '69	Am Mtl Mkt	1/16/70	2
Re-use of ferrous scrap urgently sought	Iron News	3/ /70	17
Scrap demand was high in 1969	Iron News	3/ /70	19
Scrap metals use may outpace primary in US	Metal News	3/16/70	19
Steel technology reduces demand for scrap	# Fed Clev W	3/23/70	1
Steel scrap industry aims for ductile iron boom	Iron Age	7/16/70	46
Latest Chicago ferrous scrap sales show mkt weakness	Am Mtl Mkt	11/ 9/70	22
Midwest scrap iron market rising	Am Mtl Mkt	12/24/70	1

Unit Costs,Wages & Prices

Most superalloy scrap sold overseas; US reclamamation costs too high	Ind Week	3/ 9/70	16
Scrap Institute disputes rails on scrap vs ore rates	Am Mtl Mkt	9/11/70	17
Scrap Institute states position on proposed rail rate hike	Am Mtl Mkt	11/ 9/70	10
Peril to scrap ind seen in rail rate hikes	Am Mtl Mkt	12/16/70	7
Institute of Scrap Iron & Steel attacks freight hike	Am Mtl Mkt	12/17/70	17
Steel scrap prices rise $6/ton in one month	# Wall St Jl	12/31/69	3
Mounting supply-demand imbalance causes steel scrap price to soar	Iron Age	1/ 8/70	52
Rising scrap prices mean doom for small mills	# Iron Age	1/22/70	44
Scrap price jolts electric furnaces	# Iron Age	2/ 5/70	51
New technology may force scrap prices down again	Bus Week	2/21/70	135
Steel scrap price hikes hurt electric furnace shops	# Ind Week	2/23/70	15
Scrap users told to expect another price rise	Metal News	3/ 2/70	12
Relief is in sight for high scrap prices	# Metal News	3/16/70	1
Steel scrap prices declining sharply	Wall St Jl	4/ 1/70	4
Prices of steel scrap hit record high as mills boost output	Wall St Jl	5/27/70	6
Prereduced iron ore may aid scrap price stability	Am Mtl Mkt	6/ 1/70	5
USDC says ferrous scrap exports inflate specialty steel costs; little change expected	Am Mtl Mkt	9/ 1/70	1
Ferrous scrap prices beginning to fall	Metal Bul	11/10/70	33
Year end scrap market seen as stagnant	Am Mtl Mkt	12/28/70	19

Socio-Political

$250mil initial govt fund seen for steel can salvage program	Metal News	6/15/70	1
Iron-steel-copper scrap exports put under control	Am Mtl Mkt	1/ 2/70	2
US sets copper & copper products export quotas	Metal News	1/ 5/70	23
Steel men seek curb on scrap exports	NY Times	2/18/70	61
Exports controls on ferrous scrap quota unlikely	# Iron Age	2/26/70	53
Exporters urge lifting quotas on copper scrap	Am Mtl Mkt	6/16/70	2
Scrap industry backs Laclede drive to curb scrap exports	Iron Age	6/25/70	43
Copperweld head urges steel scrap export quota	Am Mtl Mkt	8/ 6/70	1
Scrap men attack steel mills for seeking export limits	Metal News	9/ 7/70	1
Scrap industry faces environmental challenge	Am Mtl Mkt	4/ 2/70	1
Bill passed by Congress to study recovery of secondary metal	Metal Bul	10/27/70	23
Relevance of scrap ind in recycling stressed	Am Mtl Mkt	11/13/70	19

1970 continued

Autos for Scrap 50932 00			
Management Procedures			
GM launches new auto scrap plan	Am Machin	6/29/70	27
Technology			
Interior Dept plans help for junk car processing	Iron Age	4/ 9/70	19
Problems & solutions to recycling scrap autos	Metal Bul	8/ 7/70	27
Cryogenic process yields high-quality steel scrap from junk cars	#Bus Week	10/31/70	54
New car burner passes stiff pollution test	Am Mtl Mkt	5/14/70	12
Physical & Capital Resources			
Automobiles scrappage data,1980	Wards Auto	11/23/70	372
Market Data			
Junk auto disposal is growing business	#Environ Sci	1/ /70	17
USBM study values materials in junked autos	Matrl Eng	2/ /70	19
Scrap auto problems cover wide spectrum	Am Mtl Mkt	4/ 1/70	1
More aluminum use could help solve scrap autos problems	#Am Mtl Mkt	1/19/70	1
Unit Costs,Wages & Prices			
GM studies economics of junk auto disposal	Iron Age	8/ 6/70	49
Economics hamper recycling of scrap iron in junked autos	Auto News	11/ 2/70	21
Socio Political			
Govt aid needed on scrap car problem	#Am Mtl Mkt	1/21/70	1
Auto & scrap men assail plan for junk-car rebate	Metal News	8/24/70	16
GM abandoned car pickup project results pleasing	Am Mtl Mkt	9/23/70	16
Bounty system urged to salvage abandoned autos	Auto News	11/ 9/70	25

1971 (2/2/71)*

50930 00 Scrap & Waste Materials Whsle			
Scrap Metals 50931 00			
*Institutional Structure			
ISIS increases its involvement in solving problems	Am Mtl Mkt	1/11/71	7A
Look at Institute of Scrap Iron & Steel convention	Am Mtl Mkt	1/11/71	9A
*New Products & Technology			
Scrap ind counsel says recycling needs research	Am Mtl Mkt	12/21/70	3
*Utilization of Resources			
Scrap copper intake dips 7% in 1970	Am Mtl Mkt	1/20/71	11
*Production & Distribution			
'70 ferrous scrap exports seen reaching record high	Am Mtl Mkt	1/ 6/71	4
Demand for scrap metals decreases	Metal Bul	11/13/70	32
Role of scrap copper in copper mkt outlined	Am Mtl Mkt	12/18/70	1
Scrap market at year end gloomy	Am Mtl Mkt	1/ 4/71	17
Decline in ferrous scrap demand forecast	Am Mtl Mkt	1/ 5/71	2
Chicago scrap market undergoes change	Am Mtl Mkt	1/11/71	10A
Svys factors affecting scrap sales in 1971	Metal News	1/18/71	5
Changes occuring in scrap mkt won't hurt dealers	Metal News	1/18/71	5
Special RR rates for iron ore hurt ferrous scrap ind	Metal News	1/18/71	17
Record amount of scrap used & reclaimed in '70	Am Mtl Mkt	1/25/71	19
ISIS funds research for new ways of recycling metals	Am Mtl Mkt	1/11/71	17A
Time ripe for recycling ind to expand role in recovery of secondary metals	Am Mtl Mkt	12/18/70	1
New approaches for metals recycling advocated	Am Mtl Mkt	1/ 8/71	5
Ferrous scrap industry sees more pressure to recycle metals	Am Mtl Mkt	1/11/71	2A
Total involvement called key to metals recycling	Am Mtl Mkt	1/11/71	11A
*Unit Costs, Wages & Prices			
Institute of Scrap Iron & Steel opposes RR demurrage plan, barge rate hike	Am Mtl Mkt	12/18/70	18
RR freight rate hike would affect scrap recovery	Am Mtl Mkt	1/13/71	19
1971 scrap iron prices rising	Am Mtl Mkt	1/11/71	5A
Ferrous scrap prices to rise during '71 first half	Am Mtl Mkt	1/14/71	1
Autos for Scrap 50932 00			
Scrap autos seen as vast source for secondary zinc	Am Mtl Mkt	12/21/70	14
RR freight rate hike opposed by Scrap Institute	Am Mtl Mkt	12/21/70	17
Fed research urged on abandoned car problem	Am Mtl Mkt	1/12/71	14
Research on recycling auto scrap described	Am Mtl Mkt	1/15/71	16

1971 (3/2/71)*

50930 00 Scrap & Waste Materials Whsle			
Purchasing agents bothered by scrap contracts	Ind Week	1/18/71	58
High scrap prices, order backup lifts prices of second-hand ships	#Jrl Comm	1/18/71	1
Demand for steel scrap stayed strong through '70	Jrl Comm	1/18/71	4
Refuse recycling process produces steam, alumn, ferrous & non-ferrous by products	#Bus Week	1/30/71	21
Can mfrs est collectn centers for recycling	Am Mtl Mkt	2/ 3/71	1
Scrap metal recycling ind critical of freight rates	Am Mtl Mkt	2/ 4/71	2
Mkt activity in scrap metals sags severly in Midwest	Am Mtl Mkt	2/12/71	17

1971 (4/6/71)*

50930 00 Scrap & Waste Materials Whsle			
'71 ferrous scrap demand to remain at '70 level	Metal Bul	1/15/71	39
Rail freight price hike to hurt metals recycling plans	Am Mtl Mkt	2/23/71	1
Battelle Inst gives scrap metals recycling report	Am Mtl Mkt	2/24/71	17
Ferrous scrap prices drop in Midwest	Am Mtl Mkt	2/25/71	1
Industrial scrap iron prices drop	Am Mtl Mkt	2/26/71	1
GSA releasing large amounts of metal war surplus scrap	Am Mtl Mkt	3/10/71	1
'68 & '69 steel ind scrap consumption by type of furnace	#CIR M33A	3/10/71	8
Bill introduced in House dealing w/abandoned cars	Am Mtl Mkt	3/11/71	1
Svys auto scrappage statistics for '25 to '70	#Auto News	3/15/71	1

1971 (5/4/71)*

5093J 00 Scrap & Waste Materials Whsle			
Copper scrap consumption data, 1980	BDSA Outlk	1/ /71	218
Copper scrap exports data, 1980	BDSA Outlk	1/ /71	218
New record for scrap consumption set in 1971	Iron News	3/ /71	11
Copper scrap prices moving upward	Am Mtl Mkt	3/19/71	19
Inst of Scrap Iron & Steel thinks of bldg & operating Gondola fleet cars	Am Mtl Mkt	4/ 1/71	5
Direct reduction of iron ore surviving challenge of cheap scrap prices	Iron Age	4/15/71	47
Automobiles scrappage data, 1975	Am MtlMkt	3/ 4/71	10
Paper recycling rate bound to increase	Ind Week	3/22/71	21

1971 (6/1/71)*

50930 00 Scrap & Waste Materials Whsle			
Scrap Metals 50931 00			
*Institutional Structure			
Inst of Scrap Iron & Steel to est Scrap Transportat Associates	Metal Bul	3/19/71	32
*Management Procedures			
Scrap metal dealers being forced to seek new production methods	Am Mtl Mkt	4/23/71	S35
Ferrous metal casters reap benefits of new scrap processing technology	Am Mtl Mkt	5/ 3/71	5A
*New Products & Technology			
Inst of Scrap Iron & Steel oks new scrap grades	Am Mtl Mkt	4/29/71	1
Commerce Dept wants proof of purchase on copper scrap export license requests	Am Mtl Mkt	4/29/71	2
ISIS protests govt ruling on copper scrap export licenses	Am Mtl Mkt	5/ 5/71	18
*Nature & Existence of Resources			
No steel or iron scrap held in govt's stockpiles	Am Mtl Mkt	5/12/71	2
*Production & Distribution			
Bright future seen for metal scrap reprocessing ind	Am Mtl Mkt	4/23/71	S11
Look at importance of scrap ind to copper mkt	Am Mtl Mkt	4/23/71	S17
Reclaiming titanium & exotic metal scrap is profitable	Am Mtl Mkt	4/23/71	S19
Analysis of consumptn patterns of scrap zinc	Am Mtl Mkt	4/23/71	S13
Precious metal scrap need [illegible]	Am Mtl Mkt	4/26/71	1
*Unit Costs,Wages & Prices			
ISIS hits ICC scrap metal rate decision	Jrl Comm	4/29/71	4
ICC oks RR's metal scrap freight rate increase	Foundry	5/ /71	20
*Financial Data			
Look at scrap processing ind as an investment opportunity	Am Mtl Mkt	4/23/71	S35

1971 (6/29/71)*

50930 00 Scrap & Waste Materials Whsle			
Recycling of solid waste is growing business, svy	#Barrons	5/17/71	3
Waste reclamation ind booming, offers major source of raw materials	#US News	6/ 7/71	65
Scrap Inst asks Congress for freight car building aid	Am Mtl Mkt	5/21/71	1
Burglaries are a growing problem for scrap ind	Am Mtl Mkt	5/26/71	26
ISIS supports ICC decision on RR request for change in demurrage & charges	Am Mtl Mkt	6/ 4/71	13
Nonferrous fdry ind ask for further export controls on copper scrap	Metal News	6/ 7/71	19
Report on Bureau Intnl de la Recuperatn meeting	#Am Mtl Mkt	6/14/71	1A
Waste paper exports up 45% in 11 months	Paper Jour	2/ 1/71	7

* 1971 Monthly Index date

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